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JOHN MURRAY EXPEDITION

1933–34

BRITISH MUSEUM (NATURAL HISTORY)

THE JOHN MURRAY EXPEDITION 1933–34

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VOLUME IV, No. 1

CIRRIPEDIA

BY

H. G. STUBBINGS, B.A.(CANTAB.), B.SC.(LOND.)

(Late Scholar of St. Catharine's College, Cambridge)

WITH THIRTY TEXT-FIGURES

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WITH THIRTY TEXT-FIGURES.

INTRODUCTION.

THE collection of Cirripedia, though small, is of considerable interest, as it comprises, besides five new species and one new variety, many forms that have been taken only once or twice before.

The following is a list of all the species in the collection :

Lepas anserifera Linnæus.
L. anatifera Linnæus.
L. anatifera subsp. *indica* Annandale.
L. hillii (Leach).
Conchoderma virgatum (Spengler).
Pœcilasma kæmpferi Darwin.
P. (*Temnaspis*) *excavatum* Darwin.
P. crassa Darwin.
Dichelaspis tridens Aurivillius.
D. (*Octolasmis*) *nierstraszi* Hoek.
Megalasma minus Annandale.
Oxynaspis aurivillii Stebbing.
Heteralepas (*Paralepas*) *typica* Nilsson-Cantell.
Scalpellum (*Smilium*) *kampeni* Annandale.
Sc. (*Euscalpellum*) *bengalense* Annandale.
Sc. (*E.*) *rostratum* Darwin.
Sc. (*Scalpellum*) *abyssicola* Hoek.
Sc. (*Sc.*) *diota* Hoek.
Sc. (*Sc.*) *elegans* Hoek.
Sc. (*Sc.*) *elongatum* Hoek.
Sc. (*Sc.*) *formosum* Hoek.
Sc. (*Sc.*) *laccadivicum* Annandale.
Sc. (*Sc.*) *lambda* Annandale.
Sc. (*Sc.*) *longius* Annandale.

Sc. (*Sc.*) *minutum* Hoek.
Sc. (*Sc.*) *velutinum* Hoek.
Sc. (*Sc.*) *wood-masoni* Annandale.
Sc. (*Sc.*) *wood-masoni* var. *murrayi* var. nov.
Verruca (*Rostrato-verruca*) *murrayi* sp. nov.
V. (*R.-v.*) *sewelli* sp. nov.
V. (*Verruca*) *capsula* Hoek.
V. (*V.*) *macani* sp. nov.
Balanus (*Megabalanus*) *tintinnabulum* Darwin.
B. (*Balanus*) *trigonus* Darwin.
B. (*B.*) *amphitrite* var. *communis* Darwin.
B. (*Chirona*) *amaryllis* Darwin.
B. (*C.*) *albus* Hoek.
B. (*Solido-balanus*) *ciliatus* Hoek.
B. (*S.-b.*) *thompsoni* sp. nov.
B. (*S.-b.*) *echinoplacis* sp. nov.
B. (*Conopea*) *cymbiformis* Darwin.
B. (*C.*) *navicula* Darwin.
Acasta cyathus Darwin.
Tetraclita porosa var. *communis* Darwin.
Chthamalus stellatus (Poli).

In a few species, chiefly of the genus *Scalpellum*, an attempt has been made to determine the distribution, both geographical and bathymetrical. In the majority of cases the results are disappointing, owing to lack of a sufficient number of records. One or two species, notably *Sc. velutinum* Hoek, are, however, sufficiently well known to enable a distribution map to be drawn up. As far as possible the author has endeavoured to include all the records available in the literature of the species thus mapped. Where there appears to be a possibility of a relationship between two or more species, in a distributional sense, such species have been shown together on a single map, *e. g. Scalpellum elongatum* together with *Sc. novæ-zelandiæ*, and *Sc. albatrossianum* with *Sc. formosum*.

Suborder LEPADOMORPHA Pilsbry 1916.

This suborder is represented by seven genera, twelve species and one subspecies. All, except *Oxynaspis aurivillii* Stebbing and *Heteralepas typica* Nilsson-Cantell, have been recorded previously from the Indian Ocean.

Genus LEPAS Linnæus.

Four species of this genus have previously been recorded from the Indian Ocean, chiefly from the Bay of Bengal and the Indian Coast of the Arabian Sea. These are :

Lepas anserifera Linnæus.
L. anatifera Linnæus subsp. *indica* Annandale.
L. tenuivalvata Annandale, and
L. fascicularis Ellis and Solander—from the Malay Archipelago.

Of the fourth species, Annandale remarks that it has not actually been recorded from the Indian Ocean, but as it occurs in the Malay Archipelago he considers it highly probable that it occurs in the Indian Ocean, at least in the Bay of Bengal, into which the ocean currents would carry it, especially during the N.E. monsoon period. Four other species, namely :

Lepas hillii (Leach) from the South Seas (A. Menzies) and Port Stephen, Australia (Darwin),

L. pectinata Spengler, according to Darwin a common tropical form,

L. australis Darwin
L. testudinata Aurivillius } both from the Southern Ocean,

have not hitherto been recorded from the Indian Ocean ; but among the specimens of *Lepas* in the collection are two which I have assigned to *L. hillii* (Leach). As, however, they were removed from the ship's hull in Mombasa it is not possible to give their place of origin definitely, though it is certain that they came from either the Arabian Sea, or, less probably, the Red Sea, as the ship had been only a comparatively short time in this latter area.

The specimens of this genus in the present collection belong to three species, namely, *L. anserifera* Linnæus, *L. anatifera* Linnæus and its subspecies *indica* Annandale, and *L. hillii* (Leach).

Lepas anserifera Linnæus.

Lepas anserifera, Linnæus, 1788, p. 3210.
Lepas anserifera, Darwin, 1851, p. 81, pl. i, fig. 4.
Lepas anserifera, Annandale, 1909*a*, p. 75, text-fig. 2.

Occurrence.—(i) Sta. 25, Gulf of Aden, surface ; numerous specimens attached to a clump of *Sargassum*, which also harboured various other small invertebrates.

(ii) Sta. 41, South Arabian Coast, surface ; 2 specimens, one badly crushed, attached to the frond of a piece of *Sargassum*.

(iii) From the ship's side in Mombasa Harbour on January 3rd, 1934 ; 4 specimens, somewhat larger, and mature though not of full size. These specimens contain large masses of eggs.

Remarks.—All the specimens from Sta. 25 are immature. One contained two small parasitic Isopods, apparently a ♂ and ♀ of a species of Bopyrid, of which the larger, and presumably ♀, specimen appears to be immature, as it still shows considerable segmentation and retains many of the normal isopod characters.

Lepas anatifera Linnæus.

Lepas anatifera, Linnæus, 1788, p. 3211.
Lepas anatifera, Darwin, 1851, p. 73, pl. i, fig. 1.
Lepas anatifera, Jennings, 1914, p. 288, text-figs. 1–1*c*.

Occurrence.—Sta. 39, Gulf of Aden, surface ; numerous very young specimens attached to a floating cuttlefish " bone ".

Remarks.—The majority of the specimens are too small for specific determination, but the larger ones quite clearly belong to *L. anatifera* Linnæus. None of them has the row of square depressions on the capitulum.

Lepas anatifera subsp. *indica* Annandale.

Lepas anatifera subsp. *indica*, Annandale, 1909*a*, p. 76, fig. 4.

Occurrence.—Ship's side, Mombasa Harbour, 1 specimen.

Remarks.—The specimen is considerably larger than the other specimens of *L. anatifera*, though probably not full-grown, and bears a row of depressions on the capitulum. It agrees in external structure very closely with the form described as the above subspecies.

Lepas hillii (Leach).

Lepas hillii, Darwin, 1851, p. 77, pl. i, fig. 2.
Lepas hillii, Nilsson-Cantell, 1928, p. 15, text-fig. 6.

Occurrence.—To this species I have assigned 2 specimens, one large and the other small, removed from the ship's hull in Mombasa Harbour.

Genus CONCHODERMA Olfers.

This genus is represented in the collection by numerous small, though mature, specimens of *C. virgatum* (Spengler).

Conchoderma virgatum (Spengler).

Conchoderma virgatum, Darwin, 1851, p. 146, pl. iii, fig. 2, pl. ix, fig. 4.
Conchoderma virgatum, Annandale, 1909*a*, pp. 80–83 ; 1909*c*, p. 295.

Occurrence.—The bulk of the examples in the collection were scraped off the ship's side in Mombasa Harbour at the beginning of January, 1934.

Remarks.—The specimens average between 20 and 25 mm. in length, including the peduncle. They are thus by no means full grown, but that they are sexually mature is fully demonstrated by an immense mass of eggs within a specimen selected at random and dissected. The ship's hull had been scraped before the expedition sailed in the previous September, so it is evident that this species is capable of reaching maturity in three to four months, although it will then be far short of its full size. Annandale (1909*c*) records an instance of specimens of *C. virgatum* var. *hunteri* growing on a buoy in the Bay of Bengal, which had attained a capitular length of 15 mm. in the short space of eight days. The buoy was placed in the sea clean and taken up at the end of that time. There is thus no doubt that *Conchoderma virgatum* is a barnacle that develops very rapidly.

Two other examples of this species in the collection purport to come from stations 87 and 121. From the fact that they are both broken and that each has a layer of red material—presumably red-lead paint—attached to the base of the peduncle, it seems certain that these specimens were also scraped off the ship by the net, as it was being hauled, at these particular stations.

A number of the specimens are coloured a rather deep green. This is most certainly due to the fact that the specimens were stored in alcohol with a considerable amount of a filamentous green alga, also from the hull of the ship, and not to any natural variation in the colour of the species itself.

Genus POECILASMA Darwin.

Three species of this genus were obtained—*P. crassa* Darwin, *P. excavatum* Hoek and *P. kæmpferi* Darwin ; all were attached to Crustacea.

The genus *Pœcilasma* Darwin was split up by Pilsbry (1907*a*) into two genera—*Trilasmis*, for *T. eburneum* Hinds, the original type of the genus as founded by Hinds (1844), and *Pœcilasma* s. str., which he again subdivided into the subgenera *Temnaspis* and *Pœcilasma* s. str. Broch (1931) confirmed this division by a study of the development of the capitulum in young specimens. The subgenera are differentiated on the form of the capitular valves, *Pœcilasma* s. str. having the scutum entire, and *Temnaspis* the scutum divided from the very beginning. This character distinguishes *Temnaspis* from the "*Octolasmis*" group of *Dichelaspis*, in which the scutal division is secondary and due to the imperfect calcification of the valve. Both subgenera possess terga. The genus *Trilasmis* includes such species of *Pœcilasma* (*sensu lato*) as are devoid of terga, *e. g. Pœcilasma eburnea* (Hinds).

In a slightly later paper, Pilsbry (1907*b*) further restricted *Pœcilasma* by separating off those species, *e. g. P. carinatum* and *P. rectum*, in which the basal portion of the carina was enlarged. These he transferred to the genus *Megalasma*, erecting for them the new subgenus *Glyptelasma*.

Adopting this division of the genus into subgenera, *Pœcilasma* s. str. is represented by *P. kæmpferi* Darwin and *P. crassa* Darwin, and *Temnaspis* by *P. excavatum* Hoek.

Pœcilasma (*Pœcilasma*) *kæmpferi* Darwin. (Fig. 1.)

Pœcilasma kæmpferi, Darwin, 1851, p. 102, pl. ii, fig. 1 ; Annandale, 1908, pl. iii, fig. 1 ; 1909*a*, p. 90, pl. vii, text-fig. 8.
Pœcilasma (*Pœcilasma*) *kæmpferi*, Nilsson-Cantell, 1921, p. 254, text-fig. 46.
Pœcilasma dubium, Hoek, 1907, p. 6, pl. i, figs. 2–4, pl. x, figs. 1*a–d*.

Occurrence.—Sta. 106, Zanzibar Area, depth 217 metres, numerous examples attached to the carapace of a large specimen of the crab *Echinoplax pungens* Wood-Mason.

Remarks.—The examples are referable to Race II of Annandale or *P. dubium* Hoek. According to Annandale the race occurs in the Gulf of Manaar and the Malay Archipelago ; its capture off the African coast thus extends its area of distribution across the whole width of the Indian Ocean.

The species, in one or more of its five races, as given by Annandale (1909*a*), appears to be fairly generally distributed in tropical and sub-tropical seas. It has been taken as far North as the 40th parallel (in Japan) and as far South as Tasmania (Broch, 1931), but apart from these two records the main distribution of the species seems to be nearer the equator, the southern limit at about 10° S. and the northern at about 30° N., though within this belt the species has not yet been recorded from either the Pacific Ocean or the southern part of the Indian Ocean.

A single cypris larva (Fig. 1) was found attached to one of the specimens. It is tentatively referred to *P. kæmpferi*, though it is impossible definitely to assign it to any species. Three species of *Pœcilasma* were attached to the particular specimen of *Echinoplax pungens* Wood-Mason from which it was obtained. The specimens of *P. kæmpferi*, however, far outnumbered the other two species (*P. excavatum* and *P. crassa*) together. The cypris shows well-developed cirri and cypris eyes ; the peduncle is

differentiated but lies inside the shell and the small attaching tentacles are quite distinct. The mantle of the adult barnacle is visible and the scutum can be distinguished, but neither of the other two valves is visible.

Fig. 1.

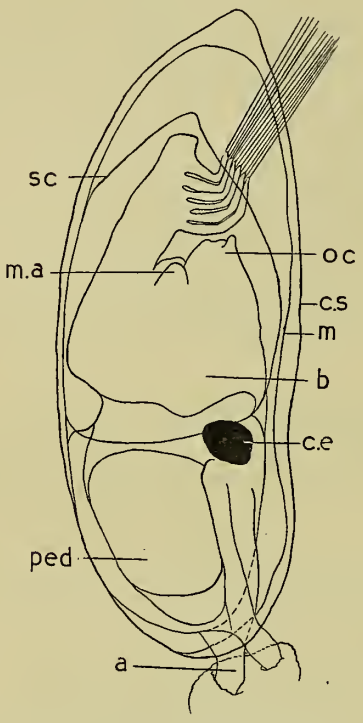
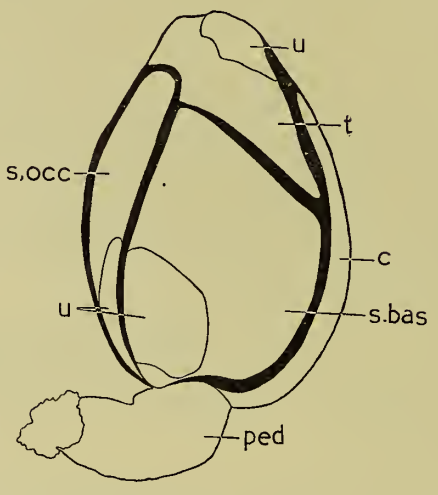


Fig. 2.



Text-fig. 1.—Cypris larva of *Pœcilasma* sp., × 48. *a.*, fixing antennæ. *b.*, body of larva. *c.e.*, cypris eye. *c.s.*, cypris shell. *m.*, mantle. *m.a.*, mouth appendages. *o.c.*, labrum. *ped.*, peduncle. *sc.*, outline of scutum.

Text-fig. 2.—*Dichelaspis tridens* Aurivillius. *c.*, carina. *ped.*, peduncle. *s.bas.*, *s.occ.*, basal and occludent portions of scutum. *t.*, tergum. *u.*, umbones of the valves.

Pœcilasma (*Pœcilasma*) *crassa* Darwin.

Pœcilasma crassa, Darwin, 1851, p. 107, pl. ii, fig. 3.
Pœcilasma (*Pœcilasma*) *crassa*, Barnard, 1924, p. 52.

Occurrence.—Sta. 106, Zanzibar Area, depth 217 metres ; 3 specimens, attached to the same specimen of *Echinoplax pungens* Wood-Mason as the previous species.

Remarks.—All the specimens are small, the largest having a total length of 7·4 mm., of which the capitulum occupies 5·5 mm. In all the specimens the tergum is exceedingly small, and only slightly wider than the upper part of the carina, or as wide as the lower part of that valve.

Subgenus Temnaspis Fischer.

Pœcilasma (*Temnaspis*) *excavatum*, Hoek.

Pœcilasma excavatum, Hoek, 1907, p. 10, pl. i, figs. 5–10.

Occurrence.—(i) Sta. 106, Zanzibar Area, depth 217 metres ; about 30 specimens attached to the crab *Echinoplax pungens* Wood-Mason with the two preceding species, a species of *Balanus* and a species of *Verruca*.

(ii) Sta. 144, Gulf of Aden, on the Arabian side, depth 220 metres; very numerous specimens on the Palinurid *Puerulus angulatus* (Spence-Bate).

Remarks.—The specimens are all young, mostly with a capitular length of less than 4·0 mm.

Genus DICHELASPIS Darwin.

Under the above genus are included the two genera *Dichelaspis* Darwin and *Octolasmis* Gray, as redefined by Pilsbry (1907*b*), and adopted by Krüger (1911) and Stebbing (1910). *Octolasmis* has been separated from *Dichelaspis* s. str. as a distinct genus on account of the calcified portion of the valves and the forked basis of the carina. *Dichelaspis* (s. str.) has the valves more strongly calcified and the basis of the carina disc-like. This genus is largely found externally on crabs, etc., whereas the species of *Octolasmis* live as commensals on the gills of crabs or Macrura or on the walls of the branchial chamber (Pilsbry, 1907*b*). Otherwise both groups of species are very similar, and it seems needless to create separate genera on the above small differences. Accordingly I have here regarded *Octolasmis* merely as a subgenus of *Dichelaspis*, distinguished by the above-mentioned differences of morphology and habitat.

In the present collection *Dichelaspis* (*sensu lato*) is poorly represented, only one species of each of the two subgenera having been found.

Subgenus Dichelaspis Darwin.

Dichelaspis (*Dichelaspis*) *tridens* (Aurivillius). (Fig. 2.)

Pœcilasma tridens, Aurivillius, 1894, p. 14, pl. i, fig. 13, pl. vi, fig. 12, pl. viii, figs. 13, 29.
Dichelaspis occlusa, Lanchester, 1902, p. 373, pl. xxxv, figs. 6, 6*c*.
Octolasmis tridens, Barnard, 1924, p. 57.

Occurrence.—Sta. 106, Zanzibar Area, depth 217 metres; 1 specimen attached to the undersurface of the carapace of a species of *Ibaccus*, probably *I. verdi* Spence-Bate, near the maxillipeds.

Remarks.—*Dichelaspis occlusa*, as described by Lanchester (1902), seemed effectually to bridge the gap between the Darwinian genera *Dichelaspis* and *Pœcilasma* by linking the more complete Dichelaspids with the less complete species of *Pœcilasma*, such as *P. tridens* Aurivillius. The inclusion of Lanchester's species with *P. tridens* and the transference of the latter to *Dichelaspis* tended to define the two genera more clearly by excluding the species with reduced valves from *Pœcilasma*. At the same time it did not militate against the possibility of their near relationship, as several nearly " complete " species of *Dichelaspis* are known.

The present specimen (Fig. 2) is exceptionally complete, being rather more so than the form described by Lanchester (1902) as *D. occlusa*. The notch in the tergum for the basal segment of the scutum is filled up so that the valve is triangular except for the deep notch for the reception of the occludent segment of the scutum. The occludent margin of the tergum is strongly bowed and almost angular, giving the valve a truncated and quadrilateral appearance. The specimen thus approaches very near to a *Pœcilasma* of the *Temnaspis* (Fischer, 1884) type with complete, unreduced tergum, but is still readily recognizable as a *Dichelaspis* by the projection of the carina between the terga.

Thus *D. tridens* now serves to link the complete forms of *Dichelaspis* with those with reduced valves, instead of illustrating a possible case of parallel reduction of the valves in the two genera *Dichelaspis* and *Pœcilasma*.

Subgenus Octolasmis Gray.

The other species of *Dichelaspis* in the collection belongs to this subgenus.

Dichelaspis (*Octolasmis*) *nierstraszi* Hoek.

Dichelaspis nierstraszi, Hoek, 1907, p. 21, pl. ii, figs. 1–7.
Octolasmis nierstraszi, Nilsson-Cantell, 1921, p. 268.

Occurrence.—(i) Sta. 27, Gulf of Aden, depth 37–92 metres ; 1 specimen, attached to a finely-branched species of Antipatharian, which also bore numerous specimens of *Oxynaspis aurivillii* Stebbing.

(ii) Sta. 146, Maldive Area, depth 37 metres ; 2 specimens on an Antipatharian.

Remarks.—According to Annandale (1910*b*), the species is common in the Malay Archipelago, where the original specimens were obtained by the " Siboga " Expedition, and has been recorded from the Bay of Bengal and the coast of Portuguese East Africa. It has not previously been recorded as far north as the Gulf of Aden, in the western Indian Ocean. The species appears to be essentially an inhabitant of shallow water. Of nineteen localities recorded by the " Siboga " Expedition only two were over 100 metres deep, the majority being from less than 60 metres.

Genus MEGALASMA Hoek.

The genus *Megalasma* is represented by specimens from three localities in the Arabian Sea ; all belong to the subgenus *Megalasma* s. str., the subgenus *Glyptelasma* being unrepresented. The latter subgenus appears to be uncommon in the Indian Ocean, where a single species, *Megalasma* (*Glyptelasma*) *hamatum* Calman (1919, p. 370), has been found once only in the Zanzibar region. It occurs abundantly, however, in the East Indies and in Australian waters and has been found frequently in the Atlantic Ocean.

Only three examples are of sufficient size for definite identification and only one species is represented, namely,

Megalasma (*Megalasma*) *minus* Annandale.

Megalasma striatum subsp. *minus*, Annandale, 1906, p. 399 ; 1908, pl. i, fig. 8.
Megalasma minus and *M. bellum*, Pilsbry, 1907*c*, pp. 409–414, text-figs. 1–7.
Megalasma minus race I and II, Annandale, 1909*a*, p. 96.
Megalasma minus, Calman, 1919, p. 361.

Occurrence.—(i) Sta. 109, Zanzibar Area, depth 641 metres ; 1 large specimen and several very small ones, attached to a small dead Cidarid covered with mucoid matter mixed with Polychæt tubes, hydroids, etc.

(ii) Sta. 115, Zanzibar Area, depth 690 metres ; 1 large specimen and three small ones, associated with a new species of *Verruca*, on the spines of a Cidarid.

(iii) Sta. 152, Maldive Area, depth 609–915 metres: 1 large dead specimen from the dried bottom sample collected with the dredge.

Remarks.—Two of the large specimens have the scutum more than twice as long as broad, but in the third (from Sta. 115) the length is slightly less than twice the greatest diameter. In this the specimen agrees with one recorded by Calman (1919, p. 362), and, as that author remarks, breaks down the boundary between *M. minus* Annandale and *M. bellum* Pilsbry. There appears to be little or no doubt that the differences in the exhaustive list given by Pilsbry (1907*c*) are all differences of variation and are not of specific value.

Genus OXYNASPIS Darwin.

Oxynaspis, Darwin, 1851, p. 133, pl. iii.
Oxynaspis, Aurivillius, 1894, p. 38.

Darwin instituted this genus, though unwillingly, for the reception of a single species of barnacle found growing on an Antipatharian and provided with spines on the capitulum. Since the publication of Darwin's work eight new species and several subspecies have been described. There are now nine "good" species of *Oxynaspis*, namely, in chronological order:

Oxynaspis celata Darwin, 1851.
O. patens C. W. S. Aurivillius, 1894.
O. aurivillii Stebbing, 1900.
O. indica Annandale, 1909*a*, 1914.
O. bocki Nilsson-Cantell, 1921.
O. terræ-novæ Totton, 1923.
O. pacifica Hiro, 1931.
O. connectens Broch, 1931.
O. pulchra Nilsson-Cantell, 1934.

All, except the last two, occur on Antipatharian corals.

These species show a considerable variation in the degree of calcification of the valves. In Darwin's species, *O. celata*, the capitulum was completely covered by the valves, the scutum being complete and trapezoid. The carina and tergum always remain well developed throughout the genus. Annandale's species, *O. indica*, is very similar to *O. celata*, in the shape and amount of calcification of the scutum. *O. connectens*, one of the two species not occurring on Antipatharia, also has complete valves, which are, moreover, very much thicker than in the species epizoic on Antipatharia. This may perhaps be correlated with the fact that the capitulum is not protected by the overgrowth of the tissues of the coral, and so has to withstand the full effects of erosion by the water and of attacks by parasites. In *O. pacifica* Hiro the first stage in reduction is seen: there is a large gap between the carina and the carinal margin of the scutum.

O. patens Aurivillius shows an increase of this reduction, in the emargination of the whole carinal-basal half of the valve, so that the scutum becomes almost triangular with the apex downwards. This process of reduction is brought to a conclusion, as far as is known, in *O. bocki* Nilsson-Cantell, in which the scutum is reduced to a long process along the occludent edge of the capitulum with a median umbo from which two short processes project towards the carina.

The species *O. aurivillii* Stebbing has the scutum roughly reduced to the shape of a trapezium by reduction of the occludent basal angle and the upper carinal (carino-tergal) angle. Reduction has thus occurred in a different manner in this species to that in the other eight. The young *O. aurivillii*, as figured by Stebbing (1900) in the original description, has an irregular strap-like scutum, resembling the scutum of *O. bocki*, but without the short lateral processes.

Over the question of the capitular spines there has been considerable controversy ever since the redescription of the genus by Aurivillius (1894). Darwin definitely stated that the spines in *O. celata* were part of " the muricated bark of the Antipathes ". Aurivillius, however, was inclined to believe that the spines were wholly formed in the chitin of the cirripede, as they appeared to be in his new species *O. patens*. Stebbing (1900) stated that in a new species described by him (*O. aurivillii*) the spines were clearly part of the cirripede chitin. Below the species are listed with the varying opinions of different authors as to the origin of the spines :

Species.	Origin of spines.	
	Cirripede.	Antipatharian.
Oxynaspis celata . . .	Aurivillius, 1894 .	Darwin, 1851. Broch, 1922.
O. patens	Aurivillius, 1894 .	..
O. aurivillii	Stebbing, 1900 .	..
	Nilsson-Cantell, 1921 .	..
O. indica	Annandale, 1909*a* .	Annandale, 1914.
O. bocki	Nilsson-Cantell, 1921 .	..
O. terræ-novæ	Totton, 1923 .	Totton, 1923.
O. pacifica	.. .	? Hiro, 1931.
O. connectens	Broch, 1931 .	..
O. pulchra	Nilsson-Cantell, 1934 .	..

The Antipatharian origin of the spines in Hiro's species *O. pacifica* is queried, as this author remarks in his diagnosis of the species that both capitulum and peduncle are " covered by chitinous horny bark ". His use of the term " bark " suggests that he considers this layer to be of Antipatharian origin.

The general consensus of opinion is thus in favour of a cirripede origin for the spines on the capitulum and peduncle, the exceptions being Darwin, who knew but the one species and admitted the bad state of preservation of his specimens, and Annandale, who on the evidence afforded by a single young specimen altered his opinion in favour of an origin from the coral skeleton. Of this specimen he says (Annandale, 1914) : " In a young specimen . . . the antipatharian has produced a flat, spiny growth over the valves, and from this growth normal branches are actually given off at the tip of each tergum of the cirripede, reaching a length of several millimetres." He adds, " There can, therefore, be no doubt that the external covering of the barnacle is produced, not by the animal itself, but by the organism to which it is attached ". He thus neglects the possibility of a dual origin for the spines.

However, a species brought back from the Pacific by Mortensen and described by Broch (1931) under the name of *O. connectens* would seem to settle the question finally. This species was found attached to a siliceous sponge, but had the usual spiniferous

cuticle. Nilsson-Cantell's species *O. pulchra* (Nilsson-Cantell, 1934) likewise has spines, though it was obtained from a telegraph cable. Broch temporized by saying that the spines, in the Antipatharian commensals, are of a dual nature, chitinous spines being produced by the barnacle, as was stated by Annandale (1909*a*) and as is shown by *O. connectens* and *O. pulchra*, and another layer over the spines being produced by the Antipatharian, as was also shown by Annandale in the passage quoted above, and is demonstrated by the fact that the coral flesh may frequently overgrow the barnacle and produce polyps on it. as may be seen in several of the specimens of *O. aurivillii* in the present collection. Broch (1922) also figures a specimen of *O. celata* var. *japonica* showing polyps on the capitulum of the barnacle. Broch evidently had in mind the possibility of the dual nature of the spines when he discussed the question in 1922. He does not, however, appear to have seen Annandale's (1914) note on *O. indica*, as he does not mention it, but only that author's earlier and opposite view (Annandale, 1909*a*).

Taking the evidence afforded by all the known species, there is now little reason to doubt that Broch's statement, that the spines have a dual origin from the cuticle of the cirripede and from the overlying skeleton of the Antipatharian, is correct for those species epizoic on Antipatharians.

Distribution of the Species of *Oxynaspis*. (Fig. 3).

In the following list the various records of the different species have been collected together :

Oxynaspis celata Darwin . (1) Madeira (Darwin, 1851).
(2) West Australia, Golo Island, Kiushiu (Nilsson-Cantell, 1921).
*(3) Japan, 33° 41′ N., 128° 50′ E. Nagasaki (var. *japonica*), 38° 12′ S., 149° 40′ E. (forma *novæ-zelandiæ*) (Broch, 1922).

O. patens Aurivillius . . (1) Antilles Sea near Anguilla Island (Aurivillius, 1894).

O. aurivillii Stebbing . . (1) New Britain (Stebbing, 1900).
(2) Bonin Island, Japan (Nilsson-Cantell, 1921).
(3) Arabian Sea, new locality.

O. indica Annandale . . (1) Off Akyab, Burma, Off Orissa coast, South of Ceylon (Annandale, 1909*a*).
(2) Off Jolo Golo (Broch, 1931).

O. bocki Nilsson-Cantell . . (1) Golo Island, (2) Kiushiu (Nilsson-Cantell, 1921).

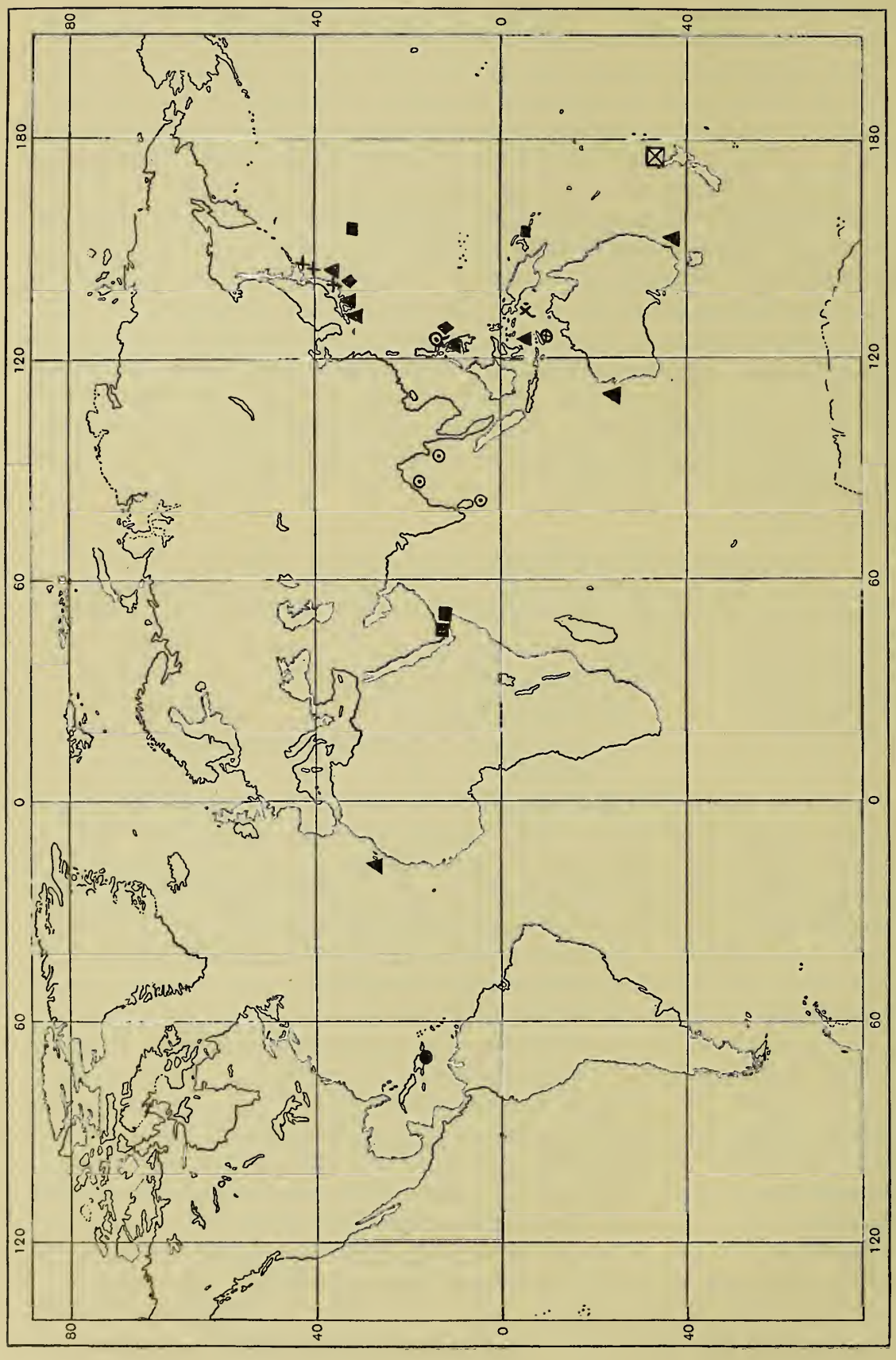
O. terræ-novæ Totton . . (1) 7 miles E. of Cape North, New Zealand (Totton, 1923).

O. pacifica Hiro . . . (1) Japan, Seto, Toba, Misaki (Hiro, 1931).

O. connectens Broch . . (1) Kei Islands, 5° 37′ S., 132° 23′ E. (Broch, 1931).

O. pulchra Nilsson-Cantell . (1) Singapore, 10° 27′ 46″ S., 126° 4′ 30″ E. (Nilsson-Cantell, 1934).

* Hiro, 1936, Japan J. Zool. Tokyo. VI, 4, p. 623, records *O. celata* from Buton Is. S.E. of Celebes.



TEXT-FIG. 3.—Distribution of the species of *Oxynaspis*.

Oxynaspis bocki ◆
Oxynaspis pulchra ⊕
Oxynaspis terræ-novæ ⊠
Oxynaspis celata ▲
Oxynaspis patens ●
Oxynaspis indica ⊙
Oxynaspis auriculi ■
Oxynaspis connectens ×
Oxynaspis pacifica +

Outside the Western Pacific, Bay of Bengal and Arabian Sea this genus has been recorded from only two localities : *O. celata* is known from Madeira and *O. patens* from the Antilles Sea. The genus is thus almost entirely confined to the east. As far as is known, the northern range seems to be about the 45th parallel. Specimens have been taken in approximately this latitude off Japan and Madeira. Except for the two Australian records of *O. celata* Darwin and that of *O. terræ-novæ* Totton off New Zealand, the southern limit of the genus is about 10° S.

The parallels of longitude 50° E. and 160° E. approximately give the western and eastern boundaries of the main distributional area. Seven species occur within this comparatively small area and six are confined to it, the only exceptions being those mentioned above, namely, *O. patens* Aurivillius, and *O. terræ-novæ* Totton, which was found rather farther to the East. *O. celata* Darwin may well prove to be of world-wide distribution either in its typical form or in one of its varieties *japonica* and *novæ-zelandiæ*.

At present no records for the genus have been obtained from the Indian Ocean proper, the Pacific Ocean east of longitude 160° E., the South Atlantic or Southern Ocean. In the northern hemisphere no records have been obtained in either the Pacific or the Atlantic north of Kiushiu and Madeira respectively ; but, as regards the Pacific, this may well be due to the paucity of our knowledge of the sea-bottom in this area. The lack of species of *Oxynaspis* in the above-mentioned areas is evidently not connected with the distribution of the Antipatharia, as species of this latter group have been obtained, and it seems probable that subsequent search will reveal species referable to *Oxynaspis* in many of these hitherto " barren " areas.

Oxynaspis aurivillii Stebbing. (Fig. 4.)

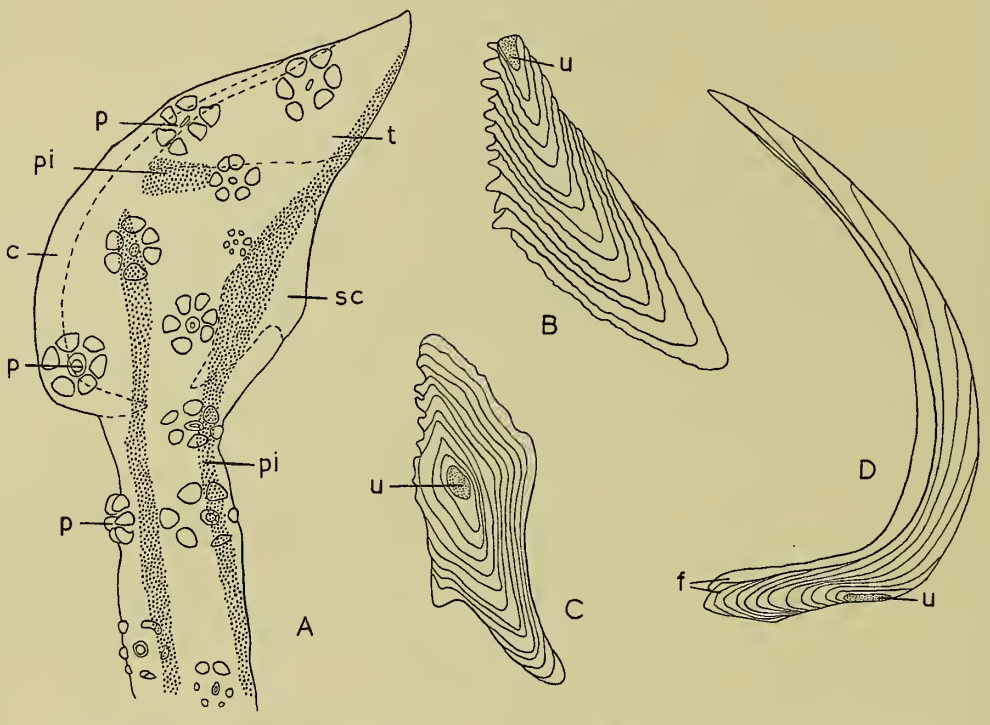
Oxynaspis aurivillii, Stebbing, 1900, p. 675, pl. lxxiv *c*.
Oxynaspis aurivillii, Nilsson-Cantell, 1921, p. 231, pl. 3, fig. 2, text-fig. 39.

Occurrence.—(i) Sta. 27, Gulf of Aden, depth 37–92 metres ; numerous specimens.
(ii) Sta. 35, Gulf of Aden, depth 453 metres ; numerous specimens. Nearly all were attached to a finely-branched, bushy species of Antipatharian, but a few from Sta. 35 were attached to a stout, sparsely-branched species.

Remarks.—The specimens agree fairly closely with Stebbing's description as modified by Nilsson-Cantell. Neither author, however, mentions the pectination of the occludent margin of the tergum and of the upper part of the same margin of the scutum. This pectination (Fig. 4 b, c) occurs in both young and adult forms, though in the smaller individuals it is not very well developed. The pectinations seem to be exaggerated crenations caused by successive growth-rings, and appear to get more irregular with each successive growth-ring.

In Stebbing's figure the organism has a patch of pigment immediately below the inferior angle of the tergum and two lines of pigment beginning in the peduncle, one running up the carinal margin and the other up the occludent side of the capitulum, interrupted by the base of the scutum and running up the inside of that valve as far as the umbo. The specimen figured by Nilsson-Cantell appears to have a small pigment patch below the scutum and a larger patch lower down on the peduncle. The present specimens closely resemble in pigmentation Nilsson-Cantell's photograph of *O. bocki*, having an occludent vertical band of pigment and a second vertical band running nearly

up the middle of the peduncle and capitulum (as seen in side view), with a small transverse patch below the tergum. In other respect, however, they do not resemble *O. bocki*, but agree with *O. aurivillii*, to which species I have assigned them.



Text-fig. 4.—*Oxynaspis aurivillii* Stebbing. A, Individual overgrown with polyps of the Antipatharian. B, Tergum. C, Scutum. D, Carina. All × c. 18. *c.*, carina. *f.*, furca of carina. *p.*, polyps of Antipatharian. *pi.*, pigment stripes. *sc.*, scutum. *t.*, tergum. *u.*, umbones of valves.

Genus HETERALEPAS Pilsbry.

This genus is represented by one species :

Heteralepas (*Paralepas*) *typica* Nilsson-Cantell.

Heteralepas (*Paralepas*) *typica*, Nilsson-Cantell, 1921, p. 250, text-fig. 45, pl. iii, fig. 3.

Occurrence.—Sta. 109, Zanzibar Area, depth 627 metres ; 18 specimens attached to broken and detached sea-urchin spines.

Remarks.—The specimens vary somewhat in size, the dimensions of extreme and average specimens being shown in the following table :

Specimen.	Total length. (mm.)	Capitular length. (mm.)	Capitular breadth. (mm.)
Largest . . .	9·0 .	4·5 .	2·5
Smallest . . .	3·0 .	1·5 .	1·0
Average . . .	6·5 .	3·5 .	2·5

The specimens are not more than half the size of the type-specimen. They agree fairly closely both in general form and in the structure of the appendages with the

published description. The following table gives comparative figures for the number of segments in the appendages for one of the present specimens and for the type (figures quoted from Nilsson-Cantell, 1921).

Specimen and size.	I.	II.	III.	IV.	V.	VI.	Caudal appendages.
John Murray specimen :							
Length of capitulum 4·5 mm. ; length of peduncle 3·0 mm.	7 7	12 13	14 15	15 16	13 15	14 13	12 (10)
Type-specimen :							
Length of capitulum 15·0 mm. ; length of peduncle 12·5 mm.	7 8	12 13	17 18	.. 19	19 19	18 18	10

The small differences in the number of segments, etc., can doubtless be put down to variation and the very immature condition of the specimens. It is remarkable that the first and second cirri have already attained their full segmentation, whereas the remainder are still from three to six segments short of the number in the adult animal. The number of segments in the caudal appendages seems to vary somewhat, regardless of the age of the individual. Of two specimens examined, one had ten segments in the appendages—as many as the much larger type-specimen—whereas the other, of about the same size, had two more than this, namely twelve. Another difference from the type, probably worthy of note, is the reduction in size of the two spines immediately below the large upper spine on the edge of the first maxilla.

Genus SCALPELLUM Leach.

As would appear to be usual in a collection of deep-sea Cirripedia, the bulk of the specimens in the present collection belong to the above genus in its widest sense, no less than fourteen different species having been obtained.

Hitherto the species of *Scalpellum* known only from Indian Seas have been classified either as species of *Smilium* or *Scalpellum* s. str.

The classification of the scalpelliform barnacles here adopted is essentially that published by Pilsbry (1908) and based upon the combination of the better features of that author's earlier paper (1907*b*) and Hoek's (1907) report on the "Siboga" material, except as regards the status to be accorded to the several divisions. Pilsbry ranks the groups *Calantica* Gray, *Smilium* Gray, *Euscalpellum* Hoek and *Scalpellum* Leach as full genera. In the present report the view of Nilsson-Cantell is adhered to and these divisions are given subgeneric value only. The diagnoses of these four subgenera are given by Nilsson-Cantell (1921, pp. 170, 174), and need not be repeated here. Following Pilsbry (1908), the subgenus *Scalpellum* s. str. is further subdivided into two groups thus :

(*a*) Infra-median latus large, pentagonal or with rounded angles, not constricted, and with the umbo varying from submedian to basal or on the rostral border, but never apical . . . . . group *Scalpellum*.

(*b*) Infra-median latus smaller than the other latera, triangular, constricted medianly, or irregular . . . . . group *Arco-scalpellum*.

The subgenus *Calantica* Gray is unknown from the Indian and Arabian portions of the Indian Ocean, though occurring abundantly off the South African Coast (Barnard, 1924) and in the Pacific (Broch, 1922, 1931). The number of species of *Scalpellum* hitherto known from the Indian Ocean is seventeen, of which three have hitherto been referred to the subgenus *Smilium* by writers on Indian barnacles, though two really belong to the subgenus *Euscalpellum*.

Of the fourteen species obtained, two, *laccadivicum* and *velutinum* were obtained twice, one, *diota*, three times and the remainder once only. Some stations yielded more than one species, on the South Arabian Coast, one, Sta. 54, *Sc. elegans* and *Sc. woodmasoni*, and in the Zanzibar Area no less than four, namely : Sta. 108, *Sc. laccadivicum* and *Sc. minutum*, Sta. 115, *Sc. diota* and *Sc. velutinum*, Sta. 118, *Sc. diota* and *Sc. formosum*, Sta. 122, *Sc. diota*, *Sc. lambda* and *Sc. longius*.

Subgenus Smilium Gray.

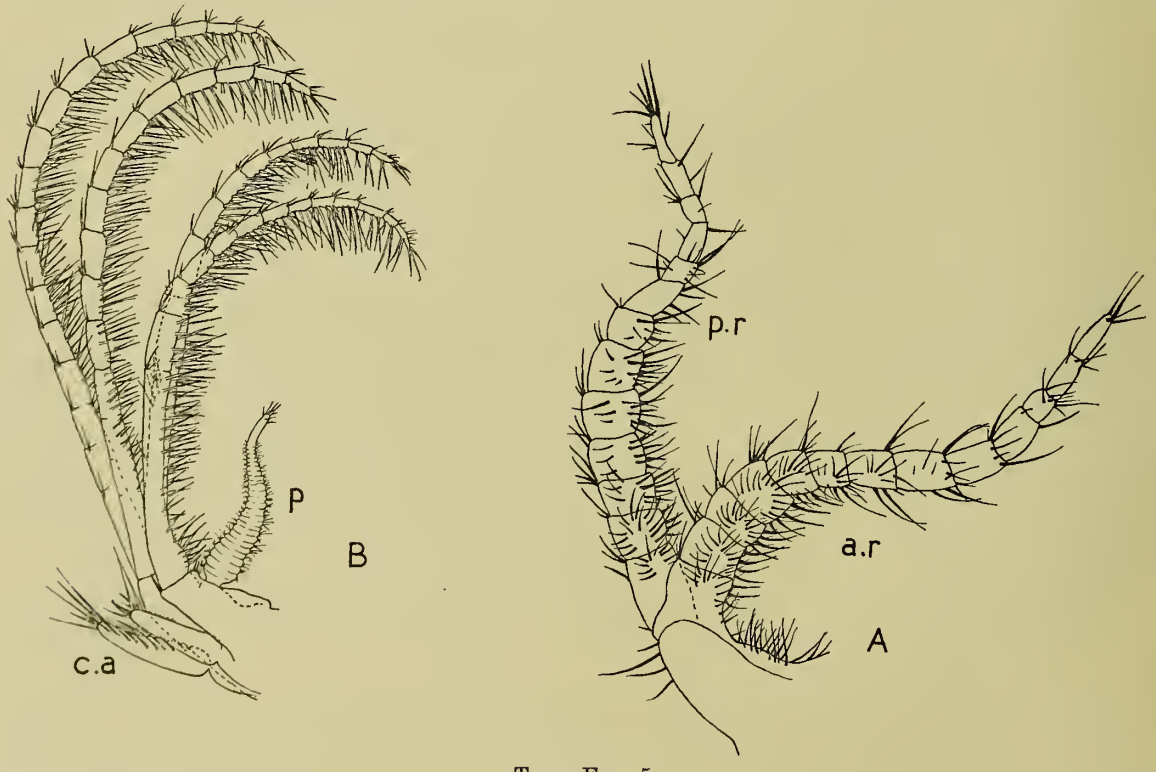
This subgenus is represented by a single species only :

Scalpellum (*Smilium*) *kampeni* Annandale.

Scalpellum (*Smilium*) *kampeni*, Annandale, 1909*b*, p. 267, text-figs. 1–4 ; 1910*c*, p. 82.

Occurrence.—Sta. 24, Gulf of Aden, depth 73–220 metres ; 2 specimens attached to a branched Hydroid, also encrusted with a sponge, *Balani* and various tubicolous Polychæts.

Remarks.—The larger specimen is of a creamy-white colour tinged with orange-pink in the region of the tergum, carina and latera, owing to the colour of the underlying membrane. The membrane appears to be white under the scutum. The external



Text-Fig. 5.

chitinous membrane is pale yellow, and bears fine hairs in irregular patches on the capitulum and peduncle. These hairs were apparently absent on the specimens from Further India and the Malay Archipelago, as they are not mentioned by Annandale.

In the shape of the different valves both specimens agree closely with the published descriptions. In the larger specimen the subcarina points directly backwards, and the carinal latera are turned upwards at the tip. In the smaller specimen the reverse is the case, the subcarina being turned up at the tip, and the carinal latera point backwards and are slightly bowed downwards.

The smaller specimen has a deep lemon-yellow capitulum owing to the colour of the underlying membrane. In other respects it falls within the limits of variation recorded by Annandale for the species. As, however, the coloration of these animals is apt to vary to a very great extent. I have no hesitation in placing the specimen in this species. Annandale records that the colour of specimens from Further India varied from deep rose-pink to milky-white ; to which must now be added the possibility of all shades from cream to the deep yellow of the above-mentioned specimen.

The dimensions of the specimens are :

Specimen.	Total length.	Length of capitulum.	Breadth of capitulum.
Larger . . .	17·0 mm.	9·5 mm.	6·0 mm.
Smaller . . .	10·0 ,,	6·0 ,,	4·0 ,,

Subgenus Euscalpellum Hoek.

This subgenus is represented by two species only.

Scalpellum (*Euscalpellum*) *bengalense* Annandale. (Figs. 5, 6.)

Scalpellum (*Smilium*) *bengalense*, Annandale, 1906, p. 395 ; 1908, pl. i, fig. 5 ; 1916, p. 129, pl. vi, figs. 3, 4, pl. vii, fig. 3, pl. viii, figs. 1–5.
Scalpellum (*Smilium*) *bengalense*, Stewart, 1911, p. 44, pl. vi, figs. 7, 10.
Scalpellum (*Smilium*) *bengalense*, Calman, 1918, p. 102, text-fig. 1.

Occurrence.—Sta. 89, Northern Area of the Arabian Sea, depth 193 metres ; 15 specimens, both large and small, attached to a Gorgonian, probably *Gorgonella umbraculum* Ellis and Solander.

Text-fig. 5.—Appendages of *Sc.* (*Euscalpellum*) *bengalense* Annandale. A, Cirrus I, × 19. B, Cirri VI and caudal appendages. C, Palpus, × 48. D, Maxilla, × 48. *a.r.*, *p.r.*, anterior and posterior rami of cirrus I. *c.a.*, caudal appendages. *p.*, penis.

Description.—The internal anatomy of the species has been described to some extent by Annandale, but no figures have appeared of certain of the mouth appendages.

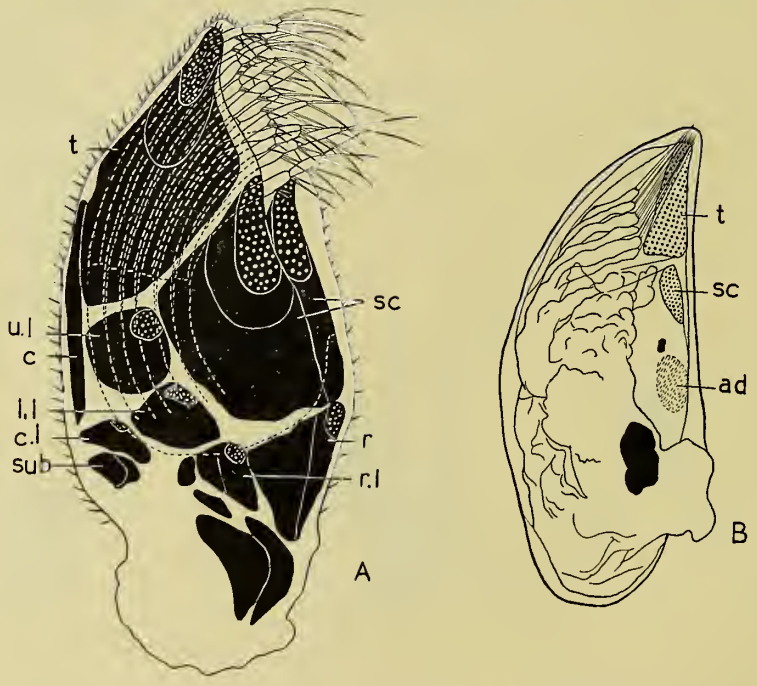
The palpus (Fig. 5 c) is conical, and bears very short setæ on the inner edge only and a tuft of rather longer and stouter setæ at the distal extremity.

The second maxilla (Fig. 5 d) is a lobe-like structure divided into three regions by slight notches in the margin. The upper and inner areas are separated by a much deeper notch than that separating the upper and outer lobes. All these lobes bear setæ; those on the outer lobe are very long and almost hair-like, some being as much as half the length of the appendage. The surface of the appendage bears a few scattered, fine, short setæ.

The cirri agree in structure with Annandale's brief diagnosis. As no figures of these have been published hitherto, I give figures of the first cirrus and also of the sixth pair together with the caudal appendages and penis. In the specimen figured the penis is rather more annulated than in the one figured by Annandale. The caudal appendages also appear to be somewhat shorter, falling short of the junction of the rami of the sixth cirrus, whereas Annandale remarks that they reach rather beyond this point.

Remarks.—The specimens agree closely with Annandale's description of the species. Several specimens were opened and all possess three ovigerous lamellæ, the middle one shorter than the other two as described and figured by Calman (1918).

Sewell (1926) has shown for *Lithotrya nicobarica* that the proportional length of the caudal appendages, in relation to the sixth cirri, decreases with the increase in size of the animal. The specimen of *Sc. bengalense* examined is smaller than that described by Annandale. Hence, if a similar condition exists in this species, it would be expected that the caudal appendages would be larger in proportion. As mentioned above, this is not so. It must not be assumed, however, that a similar type of relative growth does



Text-fig. 6.—*Sc.* (*Euscalpellum*) *bengalense* Annandale. A, Young hermaphrodite, × 48. B, Late cypris larva with developing plates, × 48. *ad.* adductor muscle. *c.*, carina. *c.l.*, carinal latus. *l.l.*, infra-median latus. *r.*, rostrum. *r.l.*, rostral latus. *sc.*, scuta. *sub.*, subcarina. *t.*, tergum. *u.l.*, upper latus.

not occur in *Sc. bengalense*, as there is great variation in the relative length of the appendages, and insufficient specimens have been examined to enable a satisfactory conclusion to be reached.

Several individuals were opened in search of complemental males. None were found, however, but two attached pupæ were found on one individual. On the occludent edge of the scutum of a second was found a young hermaphrodite with all its capitular valves developed and the scutum and tergum showing each one growth-ring (Fig. 6 A). Near this individual was attached a pupa in process of metamorphosis into the adult (Fig. 6 B). There is a distinct skin within the cypris shell, and the rudiments of scutum and tergum can be made out. The adductor muscle also is distinguishable. The peduncle has not yet straightened out, but is at right-angles to the capitular region. The nauplius eye is still present and there is no sign of the mouth-parts, the region immediately in front of the cirri being entirely undifferentiated.

Almost all the published descriptions of *Scalpellum bengalense* Annandale have appeared under the title *Smilium bengalense*. There is, however, no doubt that this species belongs to the *Euscalpellum* section of the genus, as is mentioned by Pilsbry (1908).

Scalpellum (*Euscalpellum*) *rostratum* Darwin. (Fig. 7.)

Scalpellum rostratum, Darwin, 1851, p. 259, pl. ii, fig. 7.
Scalpellum (*Euscalpellum*) *rostratum*, Hoek, 1907, p. 65, pl. v, fig. 13.

Occurrence.—Sta. 43, South Arabian Coast, depth 83–100 metres; 2 specimens attached to what appear to be fragments of chitinous Polychæt tubes.

Remarks.—The specimens agree very closely with the excellent description given by Darwin in his monograph. The peduncle, however, is rather larger than in Darwin's specimen, where it was about half the capitular length. In the present specimens the lengths are :

	I.	II.
Capitulum . . .	7·5 mm.	7·0 mm.
Peduncle . . .	5·5 ,,	5·0 ,,

Thus the peduncle in these specimens is about three-fourths the length of the capitulum.

The larger specimen was opened, but no complemental males were found attached to the integument between the labrum and adductor muscle—the position indicated by Darwin and confirmed by Hoek (1907). In the other specimen, however, two cypris

Text-fig. 7.—*Sc.* (*Euscalpellum*) *rostratum* Darwin. Cypris larva probably of a dwarf male, × *c.* 56.

larvæ were lodged within the opening of the mantle cavity attached to the chitinous membrane between the two scuta, on the occludent or outer side of the adductor muscle.

These two larvæ were stained with carbol fuchsin. Both were young and only recently attached cypris larvæ. No signs of the valves of the adult were to be seen. In one " pupa " the length/height ratio was somewhat less than in the other, and the cirri were shorter and less well developed. These peculiarities are similar to those found by Stewart (1911) for the pupa of *Sc. squamuliferum*. In this species the shorter pupa is said to be that of a male, whereas the longer one is that of an hermaphrodite. As this investigator had a large series of larval forms at his disposal, there seems no reason to doubt that this view is correct. Arguing on similar lines one would suggest that these pupæ are those of an hermaphrodite and a complemental male of *Sc. rostratum*. The supposedly male pupa is figured (Fig. 7), as it does not seem to have been figured previously, Hoek in his report on the Cirripedia only figuring the fully developed complemental male.

Subgenus Scalpellum s. str.

The remaining eleven species of *Scalpellum* all belong to the above subgenus and to the group *Arcoscalpellum* Hoek.

Scalpellum (*Scalpellum*) *abyssicola* Hoek. (Fig. 8.)

Scalpellum abyssicola, Hoek, 1883, p. 114, pl. vi, fig. 12.

Occurrence.—Sta. 185, Gulf of Aden, depth 2000 metres; 2 specimens. (This depth is considerably less than that from which the " Challenger " Expedition obtained the type-specimen, namely 2050 *fathoms*.)

Description.—This species does not seem to have been found since the voyage of the " Challenger " in 1873–76, and owing to lack of material its founder did not describe the internal anatomy of the animal. Accordingly one of the specimens has been sacrificed in order to give a description of the appendages.

The labrum is bullate and the mouth-parts small.

The mandible bears three teeth and an inferior lobe set with a number of short, tooth-like spines. The lowest tooth is slightly curved towards the inferior lobe. At the base of this tooth, and of the inferior lobe, the mandible bears a few very small setæ (Fig. 8 d).

The first maxilla (Fig. 8 e) bears eight stout spines on its biting edge, the two uppermost being very long.

The second maxilla (Fig 8 f) has slender setæ disposed in three clusters on its margin and a few short stout setæ on its surface. There is nothing peculiar in its shape.

The cirri, except for the first pair, are long and slender with cylindrical, elongated segments. The first pair are somewhat removed from the others, and have seven segments in the anterior rami and ten in the posterior. The segments, except the first in the anterior ramus and the first two in the posterior ramus, are flattened, those of the anterior ramus more so than those of the posterior. A number of setæ on the posterior face of the posterior ramus are exceedingly long, quite twice the length of the segments bearing them.

The caudal appendages are long and five-jointed, and reach just beyond the distal end of the protopodite of the sixth cirrus. They have a distal tuft of three or four long,

stout setæ and bear one or two long, hair-like setæ at the distal ends of the third and fourth segments.

There is no penis. There are no ovigerous lamellæ.

Remarks.—The specimens agree very closely with the original description and figure, especially when it is remembered that only one specimen was available for description when the species was created.

The carinal margin of the capitulum is only slightly more arched than the occludent margin, less so than is shown in Hoek's figure of the " Challenger " specimen. The tergal

Text-fig. 8.—*Sc.* (*Scalpellum*) *abyssicola* Hoek. A, Adult, × 10. One side of the capitulum removed to show the body of the animal. B, Cirrus I, × 15. C, Bases of cirri VI and caudal appendages, × 15. D, Mandible, × 48. E, Maxilla I, × 96. F, Maxilla II, × 96.

margin of the scutum is almost straight, being very slightly concave in the specimens before me, whereas the " Challenger " figure shows it as being rather markedly concave.

There is a distinct tooth on the carinal margin of the tergum, as is shown in Hoek's figure of the species, and the apex of the tergum is retroverted towards the carina, a fact not mentioned by Hoek though it is implied by his figure.

In his diagnosis of the species Hoek describes the upper latus as hexagonal, whereas his plate definitely shows a pentagonal valve. This is most certainly a textual error, as the present specimens have a pentagonal upper latus. The basal margin of this valve in the present specimens varies slightly from that of the specimen described by Hoek, in which the shorter portion abuts on the infra-median latus. In one of the specimens the basal margin is shared equally by the infra-median latus and the rostral latus. In

the others and larger specimen the rostral latus almost excludes the infra-median latus from the margin of the upper latus. These small variations, however, are of no specific value, as the variation is almost as great on the two sides of the same individual.

These two specimens are both smaller than the " Challenger " specimen, having a capitular length of 7·0 mm. and 5·0 mm. respectively as against 8·0 mm. for the type-specimen.

In both specimens search was made for dwarf males, pupæ, or young hermaphrodites, but neither specimen yielded any of these forms. The first specimen opened was in a very imperfect state of preservation and the second but little better, the body being very pulpy, so it may well be that the delicate males or larvæ were destroyed or rendered unrecognizable by the bad state of preservation of the material.

Scalpellum (*Scalpellum*) *diota* Hoek. (Fig. 9.)

Scalpellum diota, Hoek, 1907, p. 87, pl. vii, figs. 15, 15*a*.

Occurrence.—(i) Sta. 115, Zanzibar Area, depth 690 metres; numerous very small specimens, apparently referable to this species, attached to a Gasteropod shell housing a hermit crab.

(ii) Sta. 118, Zanzibar Area, depth 1792 metres; 2 large specimens.

(iii) Sta. 122, Zanzibar Area, depth 732 metres; 2 large specimens.

Description.—This species, like the preceding, was described by Hoek from a single specimen and the soft parts of the animal were not investigated. I have been unable to find any reference to the structure of the animal in subsequent literature on the genus, and so give a brief description of the animal and its appendages.

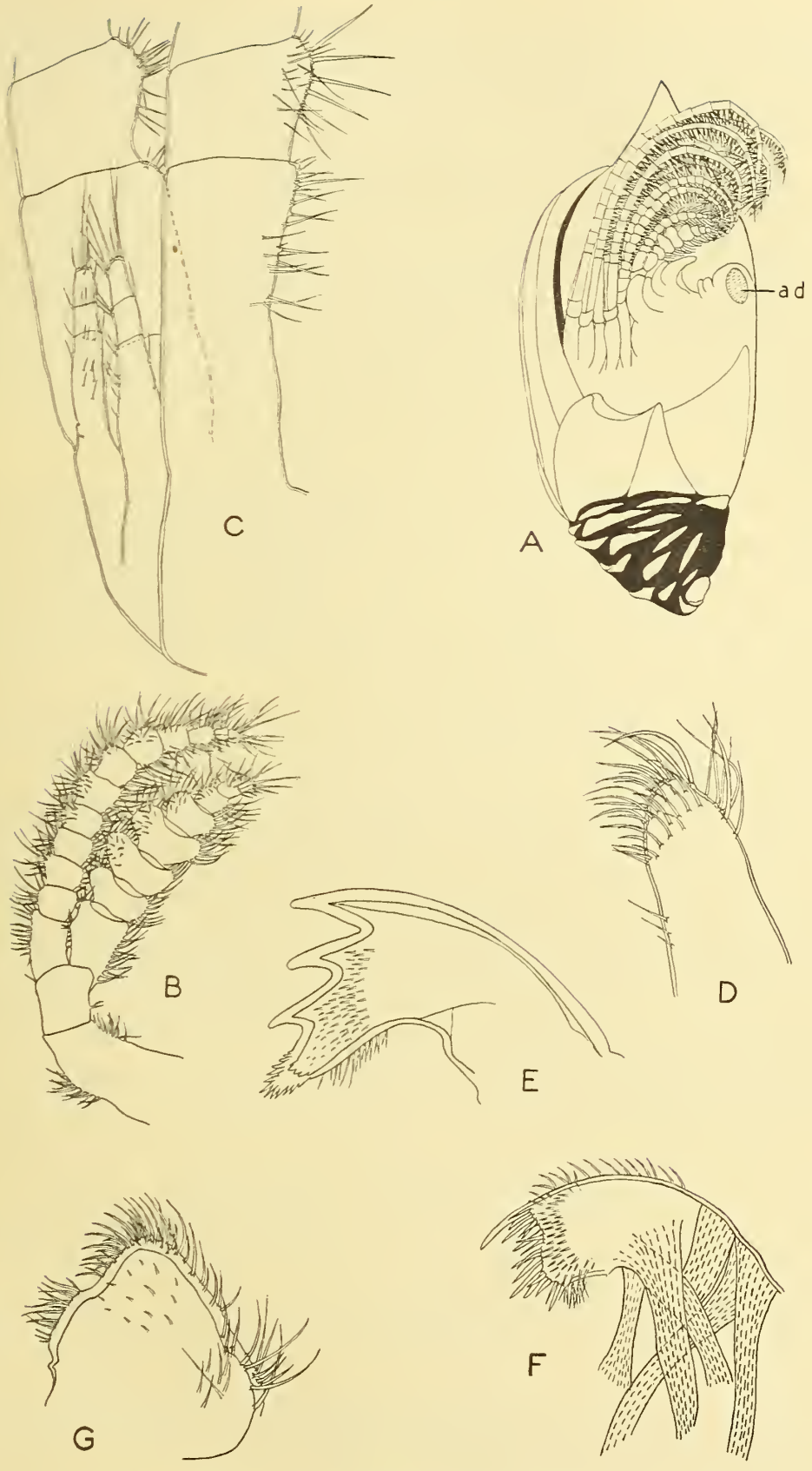
The animal, in spirit, is of a brownish tinge with traces of purple on the cirri and mouth-parts, particularly on the first two pairs of cirri. The colour in life was probably purplish, as in many of the pedunculate barnacles.

The labrum is conical and directed forwards, lying almost parallel to the body and at right angles to the long axis of the capitulum. The palpus is conical with a large crown of setæ. The mandible is three-toothed with a pectinated inferior lobe. There are short setæ on the sides of the appendage and eight or nine pairs of rather long setæ along the ventral border.

The first maxilla has a single large upper spine. The distal border of the appendage is slightly notched. The portion of the margin below the notch bears three or four spines rather larger than the remainder but inferior in size to the large upper spine. The lower portion bears nine or ten spines in all, of varying stoutness. The notch and upper portion together bear seven or eight spines below the large upper spine. The convex or outer margin bears a few slender setæ, and there is a small cluster on the very short inner margin.

The second maxilla is of the usual type, the setæ being collected into three groups. The apical group spreads in a linear manner along the outer edge of the appendage. The outer group of setæ extends on to the posterior aspect of the maxilla, and those setæ nearest the apex of the appendage overlap the lowermost setæ of the apical group. There are also a few short setæ on the posterior surface of the appendage in its distal portion.

The first cirrus is far removed from the second and is situated at a much higher level, its base being nearly level with the distal end of the first joint of the second cirrus. The first joint of its protopodite is stout and twice as long as broad. The second is as broad as long. The anterior ramus is eight-segmented and greatly flattened. The second to fifth segments have large wing-like expansions, the third and fourth being considerably



TEXT-FIG. 9.—*Scalpellum diota* Hoek. A, Complete animal with one side of capitulum removed, × 4. B, Cirrus I. C, Cirri VI and caudal appendages, × *c.* 15. D, Palpus, × 32. E, Mandible, × 20. F, Maxilla I, × 20. G, Maxilla II, × 20. *ad.*, adductor muscle.

larger than the rest. The two distal segments are very small. The posterior ramus is twelve-segmented and very nearly cylindrical. The two terminal segments are likewise very small. The first segment is approximately twice as long as broad, and the others more or less as broad as long. Both rami of cirrus I bear dense tufts of setæ on the anterior and posterior faces of the segments. There is a third dense row of setæ on the inner face of each ramus, and a few of the middle segments of both rami bear short setæ on the posterior part of the outer face.

The remaining cirri, II–VI, are uniform and have cylindrical segments about twice as long as broad, except for the elongated first segment and a few short ones following it.

The caudal appendages are short and three-segmented, reaching only about three-fourths of the way up the first segment of the protopodite of the sixth cirrus. They bear a terminal tuft of setæ reaching to the joint between segments 1 and 2 of the cirrus. The appendages bear setæ at the junction of the segments and also on the body of the first segment.

There are no ovigerous lamellæ.

Remarks.—All the specimens are white, and are devoid of the red spots mentioned by Hoek as occurring on his single specimen from the Malay Archipelago. It is highly probable that this colour is a variable character, as is the case in *Sc. rubrum*, where green and white forms have been obtained, as well as specimens exhibiting the typical red colour of the type-specimen. This is rendered more probable as, on their general form, *Sc. rubrum* and *Sc. diota* are nearly related, as is pointed out by Hoek.

Apart from this variation in colour the present specimens agree in the main with the description of the type-specimen, the only slight variation being in the infra-median latus, a valve that seems especially liable to small variations in shape. The valve broadens towards the base rather more than in the type. In some of the young specimens from station 115, however, the infra-median latus more nearly resembles that of the type. In one of the adult specimens the valve is reduced and almost conical with the upper end pointed, and is more like that figured in the " Siboga " report : it has, however, a round protuberant portion projecting from the surface of the capitulum and is almost certainly malformed. The small specimens show all gradations between the slightly expanded valve of the type-specimen and the more strongly expanded valve of the large specimens obtained by the expedition. It would thus seem that this valve has a somewhat variable shape and becomes broader with increasing age.

In two of the large specimens there is a sixth longitudinal row of peduncular plates, that, however, consists of only three or four scales.

Scalpellum (*Scalpellum*) *elegans* Hoek.

Scalpellum elegans, Hoek, 1907, p. 107, pl. viii, fig. 9.

Occurrence.—Sta. 54, South Arabian Coast, depth 952 metres ; 1 entire but broken specimen.

Remarks.—The depth is about half that (1886 metres) at which the type-specimen was found. Accompanying it in the same haul were six specimens of *Sc. wood-masoni* Annandale.

The specimen agrees fairly closely with Hoek's original description of the species.

The length of the animal is 26·5 mm., of which the capitulum occupies 18·0 mm. It is thus slightly larger than the type-specimen.

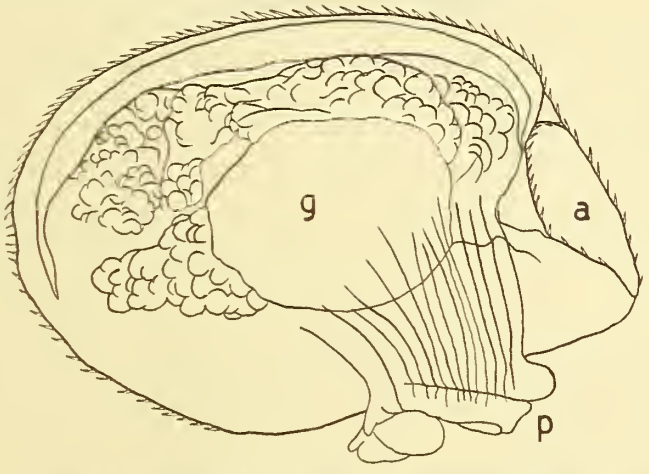
The appendages of this species were not described by Hoek, doubtless because only a single specimen was available, and the species does not seem to have been found subsequently. The specimen has not been dissected, as this would have entailed the complete destruction of an already badly damaged example.

Scalpellum (*Scalpellum*) *elongatum* Hoek. (Fig. 10.)

Scalpellum elongatum, Hoek, 1907, p. 93, pl. iv, figs. 8, 9.
Scalpellum elongatum, Nilsson-Cantell, 1928, p. 8, text-fig. 4; 1932, p. 3, text-fig. 1.

Occurrence.—Sta. 159, Maldive Area, depth 923–1662 metres; 1 specimen attached to a single valve of a dead lamellibranch, probably *Verticordia* (= *Euciroa*) *eburnea*.

Remarks.—This specimen is referred to this species, though with some hesitation, as it shows several variations from the published descriptions.



Text-fig. 10.—*Sc.* (*Scalpellum*) *elongatum* Hoek; complemental male, × 64. *a.*, aperture of mantle. *g.*, testis. *p.*, peduncle.

The general shape of the capitulum agrees with that of the type. The infra-median latus is very small and lies over the inner basal angle of the carino-lateral plate. In this it agrees with the figure of a specimen in the collection of the British Museum, published by Nilsson-Cantell (1928, Text-fig. 4).

The shape of the tergum is rather different from that in previously described specimens. The carinal angle is produced somewhat between the carina and upper latus, thus increasing the length of the carinal and scutal margins; at the same time the scutal portion of the latter margin is concave and receives the convex tergal margin of the scutum.

The peduncular scales are small, closely set, and embedded in chitin so as to be somewhat indistinct. In this they differ somewhat from any of the published figures which show these scales as fairly distinct.

As this species seems to be very variable in appearance I have referred the present specimen to it rather than risk creating a new species for its reception, a procedure, in the opinion of the writer, to be avoided if possible in a genus as variable and imperfectly known as *Scalpellum*.

Two complemental males were attached to this specimen, just within the mantle cavity in fossettes, 1 to 2 mm from the occludent margin of the scutum about the middle of the margin. Both were situated on the left side of the animal. The dwarf male is devoid of plates, oval, and sac-like. The peduncle is short and distinguishable on account

of its longitudinal muscle-fibres. The testis is a large spherical body lying in the centre of the animal. The opening of the mantle is oval, or round, and small. The mantle is covered externally with short, simple setæ.

Scalpellum (*Scalpellum*) *formosum* Hoek.

Scalpellum formosum, Hoek, 1907, p. 110, pl. viii, figs. 11, 11*a*.
Scalpellum formosum, Nilsson-Cantell, 1921, p. 187, text-fig. 27.

Occurrence.—Sta. 118, Zanzibar Area, depth 1792 metres; 1 specimen in the same haul as two of the larger specimens of *Sc. diota*.

Remarks.—It closely resembles the description of the type-specimen. The rostrum is very narrow and is almost covered by the rostral latera, as in one of the two " Siboga " specimens.

No dwarf males or developmental stages were found attached to the specimen.

Scalpellum (*Scalpellum*) *laccadivicum* Annandale.

Scalpellum laccadivicum, Annandale, 1906, p. 393; 1908, pl. i, figs. 3, 4.
Scalpellum polymorphum, Hoek, 1907, p. 86, pl. vii, figs. 9–11.

Occurrence.—(i) Sta. 107, Zanzibar Area, depth 439 metres; 2 specimens.

(ii) Sta. 108, Zanzibar Area, depth 802 metres; 1 specimen attached to a piece of dead *Lophohelia*-like coral, covered with a dense growth of sponges and other epizoic organisms.

Remarks.—All the specimens resemble the complete form (form A) of *Sc. polymorphum* Hoek more closely than the typical *Sc. laccadivicum* of Annandale. However, the specimens have many points in common with both forms, and it seems advisable to include them all under one species, as is done by Annandale.

As regards depth, the specimens come well within the previously recorded range of the species. According to Annandale (1913) the shallowest known habitat was that recorded by the " Siboga " off the Kei Islands and Sumbawa (397 metres). At the other extreme we have specimens obtained by the R.I.M.S. " Investigator " in the Laccadive Sea at a depth of 1154 fathoms (2130 metres).

Scalpellum (*Scalpellum*) *lambda* Annandale.

Scalpellum lambda, Annandale, 1910*a*, p. 115; 1916, p. 127, pls. vii, viii.

Occurrence.—Sta. 122, Zanzibar Area, depth 762 metres; 1 specimen.

Remarks.—It agrees very closely with Annandale's description of the type, although an " incomplete " species and hence, perhaps, more liable to variation in the shape of the valves than a " complete " species. The specimen is in no wise intermediate in form between this and *Sc. longius* of the same author. It thus tends to justify Annandale's separation of these two forms as distinct species, though at the time he apparently had some doubts as to the justification of this step, as he remarks (1913, p. 235), " Possibly *Scalpellum longius* as here described is merely a complete form of *S. lambda* . . . ". The validity of these two species is further discussed from the distributional standpoint on p. 60.

The appendages were examined and commented upon in the original description, and as the present collection only contains a single example of the species, I have not dissected it in order to figure those appendages, illustrations of which were not published by Annandale. namely the palpus, second maxilla and first cirrus.

No dwarf males or developmental stages were present except a single egg lying free in the mantle cavity.

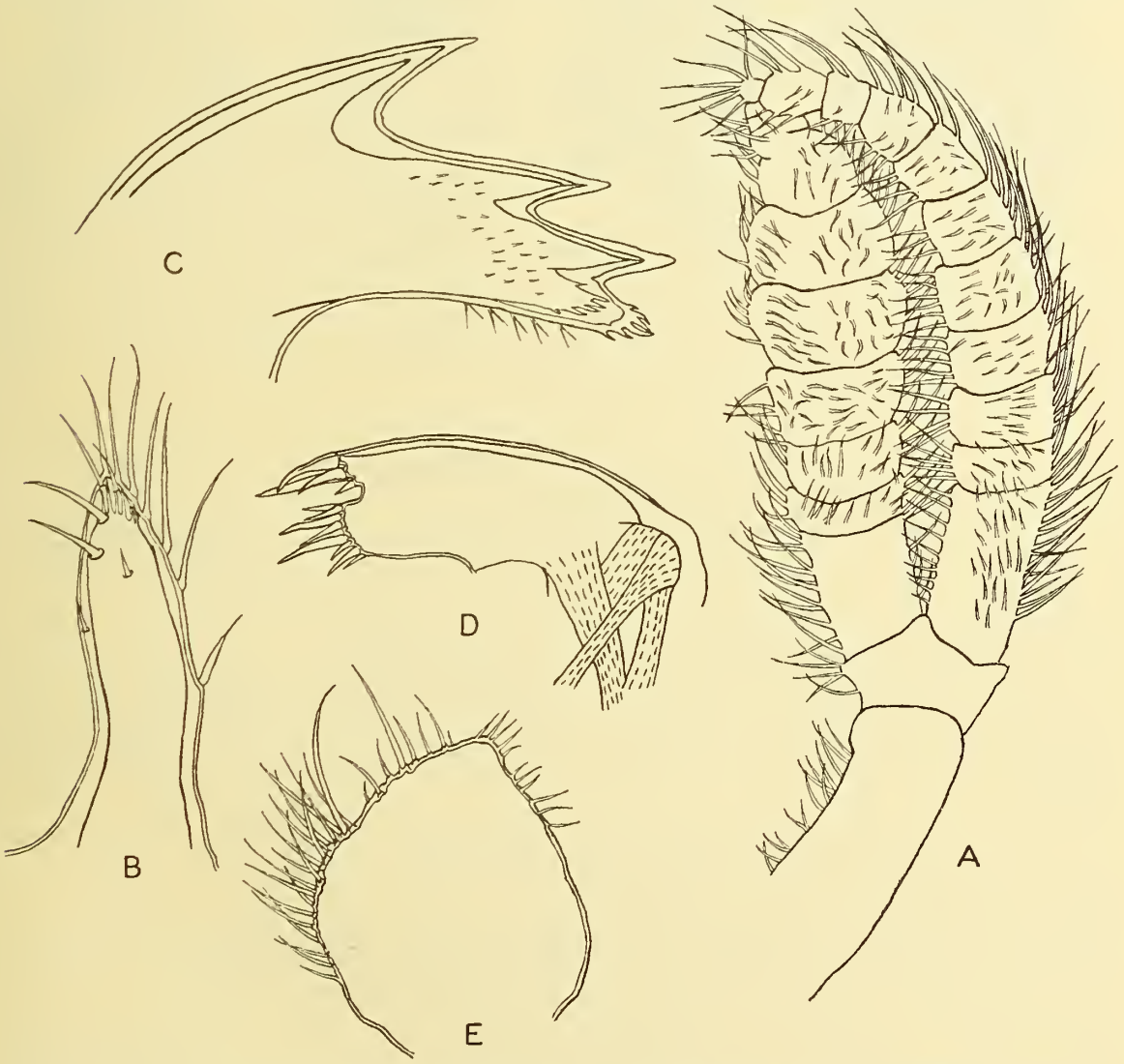
Scalpellum (*Scalpellum*) *longius* Annandale. (Fig. 11.)

Scalpellum longius, Annandale, 1913, p. 234 ; 1916, p. 130, pl. vii.

Occurrence.—Sta. 122, Zanzibar Area, depth 762 metres ; 2 specimens.

Description.—The palpus is simply conical, and bears about ten long apical setæ and a few short ones on the surface of the appendage.

The mandible differs somewhat from the description given by Annandale in the shape of the inner angle and in the number of its spines. Annandale says, " . . . the inner angle is produced and forms a projecting portion of relatively large size and with nearly parallel but somewhat irregular edges ; at its extremity it bears two teeth ". In the present specimen the inner angle is no longer than the lowest tooth. Its extremity is rounded and bears six small teeth. The two outer teeth are rather lateral in position



Text-fig. 11.—*Sc.* (*Scalpellum*) *longius* Annandale. A, Cirrus I, × *c.* 33. B, Palpus, × 48. C, Mandible, × 48. D, Maxilla I, × 30. E, Maxilla II, × 30.

and the other four terminal, the two upper curving slightly towards the two lower, which curve in the opposite direction.

The first maxilla bears four spines above the anterior notch ; the three upper are large and subequal, the lowest is much smaller. There are eight to ten smaller spines on the portion below the notch.

The second maxilla is oval with the setæ arranged in only two groups, instead of three as in many species of *Scalpellum*. The inner group is lacking. The apical tuft consists of only a few small slender setæ.

The first cirrus has the rami subequal in length. The anterior ramus is flattened, eight-segmented, and almost straight. The posterior ramus is only slightly flattened, eleven-segmented, and slightly bowed.

The caudal appendages are eight-segmented, the second and third segments being very small. These appendages agree very closely with Annandale's figure of the same structures in *Sc. lambda*.

Remarks.—The specimens agree closely with the description of the type and show no tendency to vary towards *Sc. lambda*.

This species has not been described since the original diagnosis was published in 1913. Only the external appearance of the type has been figured (Annandale, 1916). Accordingly I have here figured the mouth-parts of this species, at the same time mentioning any variations from the type description which occur in the present specimens.

The less well-preserved of the two specimens was dissected. The valves of one side were smashed, but showed a swelling about the region of the upper latus on that side. On opening the capitulum the cause of the swelling was found to be two large females and a male of some species of Bopyrid. The parasites had apparently inhibited the development of the sixth pair of cirri and of one of the fifth pair. All the other appendages and the caudal appendages were fully developed.

Scalpellum (*Scalpellum*) *minutum* Hoek.

Scalpellum minutum, Hoek, 1883, p. 113, pl. v, fig. 12.

Occurrence.—Sta. 108, Zanzibar Area, depth 802 metres ; 1 specimen attached to a piece of dead coral of *Lophohelia* type, encrusted with a felt of sponge.

Remarks.—This exceedingly small species of *Scalpellum* does not seem to have been found since the " Challenger " obtained the type-specimen.

The specimen is 3·5 mm. long and is considerably smaller than the type, which had an overall length of 8·0 mm. In view of the evident youth of the specimen the internal anatomy is not figured here, although no figures of the appendages have hitherto been published.

Scalpellum (*Scalpellum*) *velutinum* Hoek. (Fig. 12.)

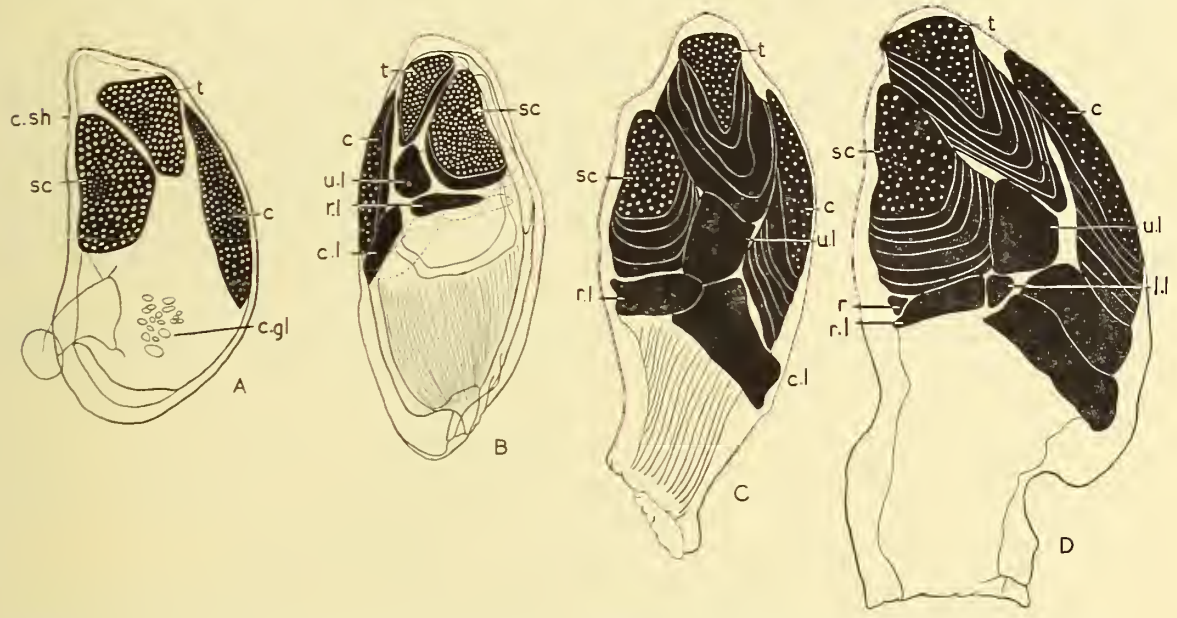
Scalpellum velutinum, Hoek, 1883, p. 96, pls. iv, ix.
Scalpellum velutinum, Gruvel, 1902, pp. 56–63, pl. ii, figs. 3*c*, 10, 14, pl. iii, figs. 27–31, pl. iv, figs. 6, 11–22.
Scalpellum velutinum, Nilsson-Cantell, 1927, p. 743, text-fig. 1 ; 1928, p. 4 ; 1932, p. 1.
Scalpellum eximium, Hoek, 1883, p. 100, pl. iv, figs. 6, 7, pl. x, figs. 10, 10*.

Occurrence.—(i) Sta. 115, Zanzibar Area, depth 690 metres ; 1 large and several young specimens attached to a piece of pumice.

(ii) Sta. 122, Zanzibar Area, depth 762 metres ; 4 large specimens on a piece of coral.

Remarks.—The specimen from Sta. 115 is considerably larger than the others and is practically devoid of hairs : the chitinous membrane is very thin and absent from the apices of some of the valves. The four specimens from Sta. 122 are all of the very hairy type. Numerous newly metamorphosed specimens, apparently of the same species, and several cypris larvæ of varying ages were attached to the large specimen from Sta. 115 and to the piece of pumice.

Several of the specimens contained dwarf males. The position and number of these complemental males seems to vary considerably. As regards their position Hoek (1883) merely remarks " attached to the left-hand scutum "—referring to one of two individuals from a single specimen of *Sc. velutinum*. In the line before he says, " there are not more



Text-fig. 12.—*Sc.* (*Scalpellum*) *velutinum* Hoek. Stages in the development of the adult. A, Late cypris larva. B–D, Young hermaphrodites. *c.*, carina. *c.gl.*, cement gland. *c.l.*, carinal latus. *c.sh.*, cypris shell. *l.l.*, infra-median latus. *r.*, rostrum. *r.l.*, rostral latus. *sc.*, scutum. *t.*, tergum. *u.l.*, upper latus. All × *c.* 16.

than one on each side ". For his species *Sc. eximium*, now regarded as synonymous with *Sc. velutinum*, he merely states that the males are found " at the ordinary place ".

Gruvel gives much more precise data for the position of these individuals. He says (Gruvel, 1902) : " Ces petits êtres se trouvent situés, en grand nombre généralement, dans une duplicature du manteau formant une sorte de fossette placée à la partie interne du scutum. Cette fossette commence à 4 millimètres environ de l'apex de la plaque. Elle s'étend sur une longeur et une profondeur à peu pres égales, en s'arrêtant immédiatement au dessus du muscle adducteur ". This information is certainly sufficiently precise. He then adds that from four to twelve males may be found in this position. In the specimens I examined four males were obtained, one of which is still within its cypris shell, but is definitely a male as it shows the characteristic covering of pectinated setæ. Of these, three were found on one individual. Their position, however, does not altogether agree with that given by Gruvel, as they were attached between the two scuta in the depression formed between them and the adductor muscle. Evidently therefore the

position of the complemental males can vary to some extent, though they do not migrate very far into the mantle cavity itself.

The structure of the dwarf males agrees very closely with the figures published by Gruvel (1902) in his report on the " Talisman " cirripedes.

A number of very young hermaphrodites were obtained from the large specimen, some attached to the peduncle or substratum, and others from just within the mantle cavity on the scutal edge near the position occupied by the dwarf males when present. I have figured several of the youngest in order to show the development of the capitular valves. The youngest specimen (Fig. 12 A) is still enclosed in the cypris shell and has not yet straightened out. The umbones of the tergum, scutum and carina are present and are of considerable size, covering over half the capitular portion of the animal. There are as yet no traces of the upper latus or of the lower whorl of valves.

The next specimen figured shows slight additions to the upper whorl of valves, and the upper latus and two of the lower whorl of latera, the carinal latus and what, from its shape, should be the rostral latus, have made their appearance. The latter valve, however, lies half under the upper latus and does not reach to the occludent margin. There is as yet no trace of a third valve in the lower whorl. The peduncle has straightened out and the attaching antennæ are distinctly visible. There are, however, no peduncular scales as yet.

In the third specimen figured (Fig 12 C), the animal begins to take on the adult shape. The valves have considerably increased in size. The scutum and tergum show four growth-rings and the carina five. The upper latus, carinal and rostral latera also have increased in size. The two last-named overlap slightly, and there is still no trace of an infra-median latus. All the valves are now in contact over a considerable portion of their periphery. The peduncle is slightly constricted off from the capitulum and has a definite flat base of attachment. The antennæ are no longer visible.

At a still later stage the first peduncular scales appear on the carinal side just below the carinal latera. These scales appear to develop before the infra-median latera, as specimens occur in which they are present and the infra-median latera are absent, and also slightly larger specimens in which both are present. Fig. 12 D shows an individual with all the capitular valves and the first peduncular scales. The rostrum seems to appear between the development of the first peduncular scales and the infra-median latus.

The majority of the peduncular scales seem to vary in time of origin. Some specimens show distinct white transverse markings on the peduncle, denoting the position of the developing scales, even before the infra median latera have developed. On the other hand they may still be absent in specimens with a complete set of capitular plates.

Scalpellum (*Scalpellum*) *wood-masoni* Annandale.

Scalpellum wood-masoni, Annandale, 1906, p. 396 ; 1908, pl. i, fig. 1.
Scalpellum wood-masoni, Nilsson-Cantell, 1932, p. 3, text-fig. 2.

Occurrence.—Sta. 54, South Arabian Coast, depth 952 metres ; 3 specimens associated with *Sc. elegans* on a tubular branching sponge.

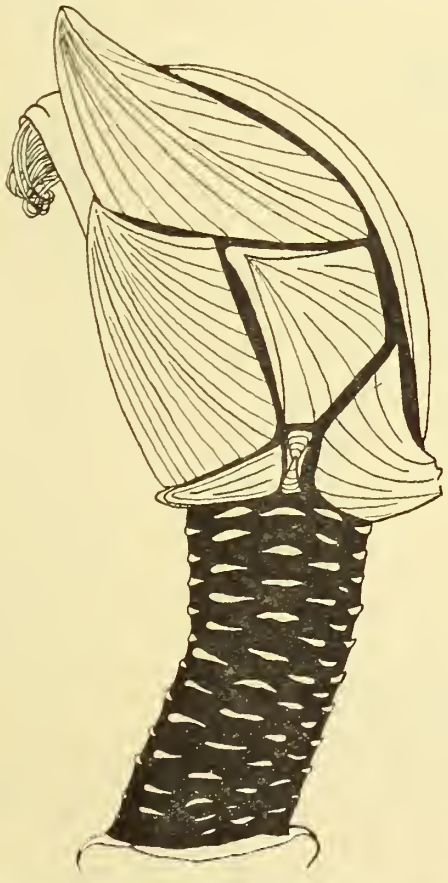
Remarks.—These specimens agree reasonably closely with the descrip ion of the type. The carina is somewhat more concave than is implied by Annandale's description.

His expression is " dorsal surface flat or feebly concave ". The dorsal surface is very definitely concave in all the specimens collected from this area. Annandale adds that the dorsal surface of the carina is " without definite borders ". In the present specimens the three regarded as most typical are variable as to this character. One may be regarded as having the dorsal surface of the scutum bounded by ridges formed by the concave nature of the dorsal surface itself. In the other two specimens the carina is definitely possessed of borders. The other valves agree with the diagnosis of the species.

Scalpellum (*Scalpellum*) *wood-masoni* var. *murrayi* var. nov. (Fig. 13.)

Occurrence.—Sta. 54, South Arabian Coast, depth 952 metres ; 3 specimens.

Remarks.—These specimens differ in several characters from the typical form. The capitulum is covered by a very much paler chitinous membrane. The occludent margin is not straight, but both scutum and tergum have curved occludent margins, the two curves intersecting where the apex of the scutum overlaps the tergum. The apex of the tergum has a tendency to be slightly retroverted towards the carina. This is most marked in the specimen with the least straight occludent margin. The most striking difference, however, is in the infra-median latus. This plate is horn-shaped and slightly retroverted towards the occludent margin of the capitulum in the typical form. In these specimens, however, the umbo is median and the valve is hourglass-shaped and slightly turned, in the upper part, towards the carinal margin of the capitulum. In the



Text-fig. 13.—*Sc.* (*Scalpellum*) *wood-masoni* Annandale var. *murrayi*. Specimen showing the hourglass-shaped infra-median latus.

smallest specimen, however, the upper part of the hourglass-shaped valve is only feebly developed.

No dwarf males were present on either the typical form or the variety.

Suborder VERRUCOMORPHA Pilsbry 1916.

Genus VERRUCA Schumacher.

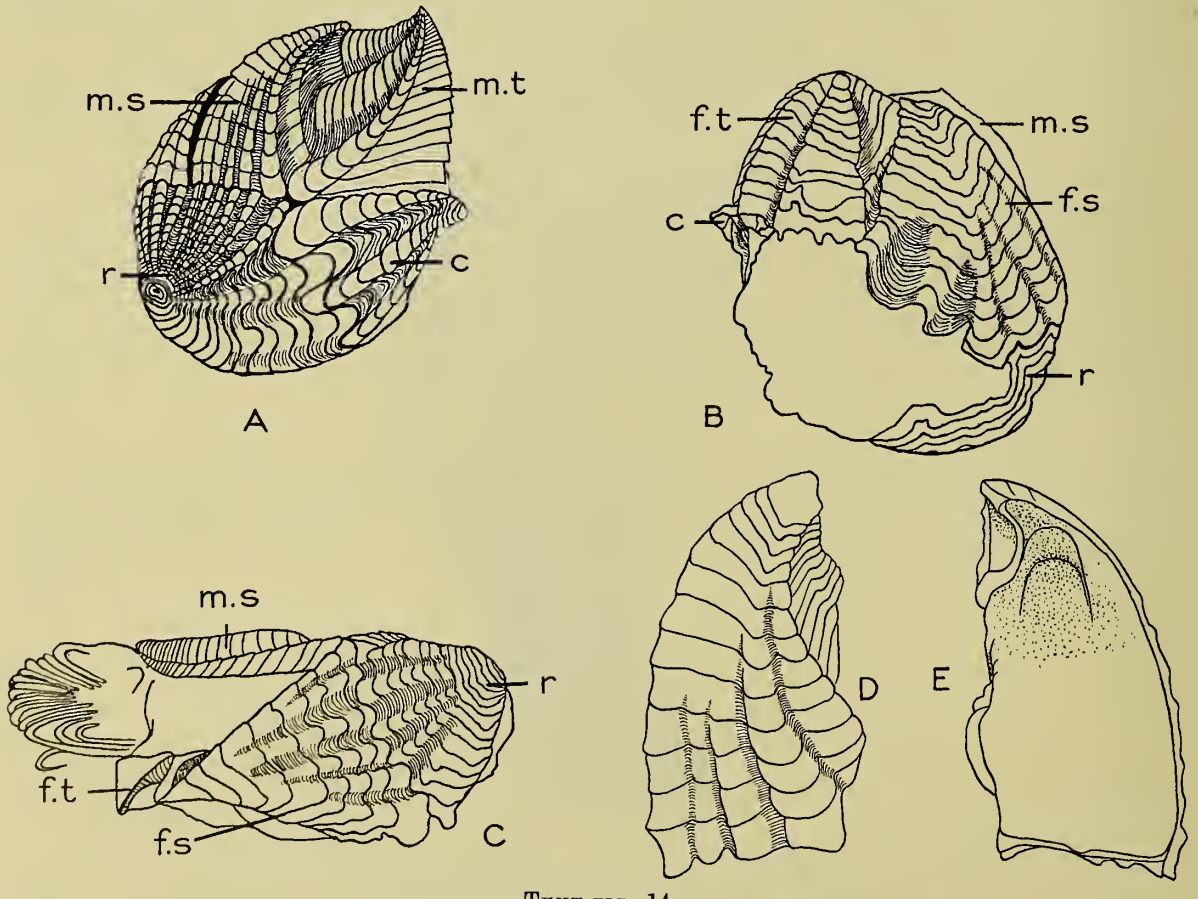
Representatives of this genus were collected at four stations in the Arabian Sea, four species being collected in all, and of these three must be considered as new to science and are described below. Two, *V. murrayi* sp. nov. and *V. sewelli* sp. nov., were the only species to be obtained at more than one station and both belong to the subgenus *Rostrato-verruca* Broch ; the third, *V. macani* sp. nov., belongs to the subgenus *Verruca* (s. str.) of Pilsbry.

Verruca (*Rostrato-verruca*) *murrayi* sp. nov. (Fig. 14.)

Occurrence.—(i) Sta. 105, Zanzibar Area, depth 310 metres ; 1 specimen.

(ii) Sta. 110, Zanzibar Area, depth 333 metres ; 8 specimens.

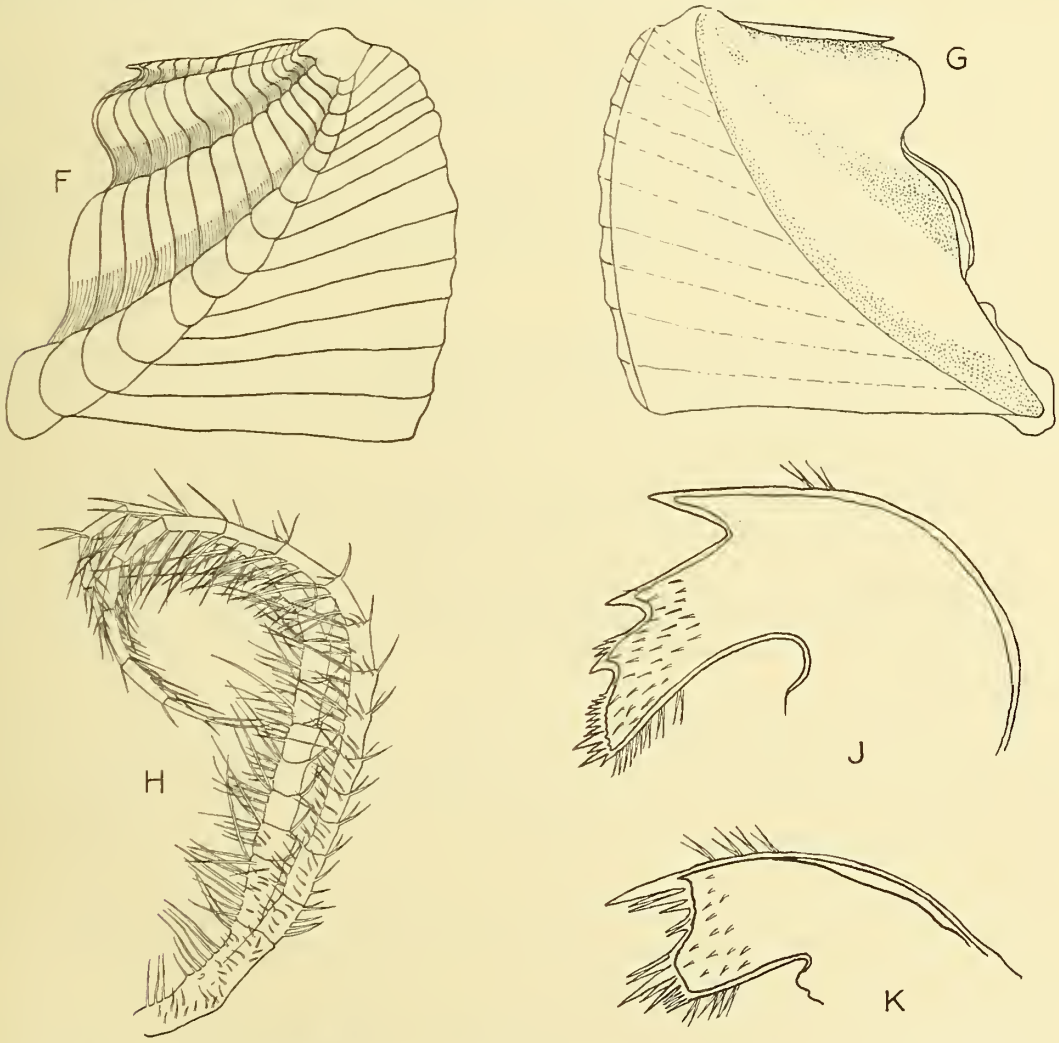
Diagnosis.—Basis rounded ; rostro-carinal wall strongly convex dorsoventrally, the upper part parallel to the plane of the basis ; rostrum patelliform, larger than carina, nearly twice as large when viewed from above (Fig. 14 A), with the umbo much removed from the scutal border, sub-central ; articular edges of rostrum and carina forming an angle of about 170° ; umbo of carina produced ; scuto-tergal wall very oblique ; basal



Text-fig. 14.

edge of wall not inflected : movable operculum more or less parallel to basis ; movable scutum and tergum with three articular ridges ; carina and rostrum articulating by three strong ribs.

Description.—The movable scutum is small, slightly larger than the ribbed portion of the movable tergum, and approximately triangular. The occludent margin is convex ; the basal margin straight and feebly crenulate owing to the ribs articulating with the rostrum. The apex is pointed and projects slightly over the first ridge of the tergum. Three ridges articulate with the tergum, the first short and separated by a wide furrow from the second. The second is long, running from near the umbo to the articular margin, strongly curved and prominent. The axial ridge is slightly longer than the second and of the same width ; it terminates on the basal margin. Both edges of the ridge are sharply demarcated. Three or four ridges articulate with the rostrum, the first two with definite borders, the other one or two indistinct.



Text-fig. 14.—*Verruca* (*Rostrato-verruca*) *murrayi* sp. nov. A, From side of movable scutum and tergum. B, From side of fixed scutum and tergum. C, Lateral view. All × *c.* 45. D, E, Scutum, external and internal view. F, G, Tergum, external and internal view. H, Cirrus III. J, Mandible, × 96. K, Maxilla I, × 96. *c.*, carina. *f.s.*, *f.t.*, fixed scutum and tergum. *m.s.*, *m.t.*, movable scutum and tergum. *r.*, rostrum. A, B, C are from the type-specimen.

The movable tergum is large and quadrilateral with three articular ridges. The upper margin is formed by the first ridge and is concave. The scutal margin is sinuous ; the basal straight and the posterior occludent margin feebly convex. The second ridge is separated from the first by a wide furrow ; it is broad with distinct sides. The third or axial ridge extends diagonally across the whole valve and is little more than half as broad as the second. The postaxial portion of the tergum is ornamented by prominent growth-ridges only.

The rostrum has three prominent ridges articulating with the carina, the uppermost very narrow with a deep furrow on either side. The other two have more gently sloping sides and are separated by a shallow furrow. There is a small and irregular, rudimentary, fourth ridge below these. Four small and narrow ridges articulate with the basal border of the movable scutum. The vertical portion or paries of the valve has two broad regular ridges running from the umbo to the basal margin. The rostrum articulates with the fixed scutum by four indistinct narrow ridges.

The carina articulates with the rostrum by three ridges, the two uppermost broad and curving slightly towards the basal margin. The third is narrow and irregular. There are no other ridges on the carina.

The fixed scutum is trapezoid. The basal margin is crenulate and parallel to the occludent. The latter is slightly convex near the umbo, which is bent towards the fixed tergum. The rostral border is crenulate, and articulates with the rostrum by four rather irregular ridges. A small radial area with a very oblique upper margin is present on the tergal side.

The fixed tergum consists of a triangular parietal area with very irregular growth-lines. On the scutal side a triangular alar area meets the radius of the scutum. A larger radial area on the carinal side articulates with the carina. Both ala and radius are ornamented with growth-ridges only.

The mandible has three sharply acute teeth and a large inferior angle with nine small teeth. There are three minute teeth on the upper edge of the third tooth.

The first maxilla has the upper part of the anterior margin cut away. There is one large upper spine with a pair of shorter ones below, followed by three short ones ; these spines are widely spaced. There is a spineless gap before the lower teeth, two of which are enlarged.

Cirrus I is somewhat removed from the second. The anterior ramus is about two-thirds as long as the posterior, and consists of eight segments, as broad as they are long. The posterior ramus consists of eleven segments all longer than they are broad, the lowest about one-and-a-half times as long, increasing to three or four times as long as broad at the tip.

Cirrus II is removed slightly from the third, and the anterior ramus is about three-fourths the length of the posterior. The number of segments is nine and thirteen in the anterior and posterior ramus respectively.

Cirri III–VI have equal rami of from sixteen to eighteen segments. The setæ are very long and hair-like (Fig. 14 H), some of them more than three times as long as the segments bearing them.

Remarks.—This species is characterized by the very oblique scuto-tergal wall, which gives the barnacle the appearance of being pushed over to one side by the comparatively large area of the rostrum between the umbo and the scutum. It is

distinguished from the other species of the subgenus *Rostrato-verruca* by the absence of an inflected edge to the walls (*cp. V. nexa* Darwin), by having only three articular ridges on the movable scutum and tergum (separating it from *V. koehleri* Gruvel, 1907), and by the oblique position of the scuto-tergal wall, which easily distinguishes it from the other three species of this group, namely *V. dens* Broch (1931), *V. intexta* Pilsbry (1912) and *V. krugeri* Broch (1922).

This species is named in honour of Sir John Murray, one of the naturalists on the "Challenger", and later editor of the "Challenger" Reports', by whose bequest the expedition was made possible and from whom it derived its name.

Verruca (*Rostrato-verruca*) *sewelli* sp. nov. (Figs. 15, 16.)

Occurrence.—(i) Sta. 109, Zanzibar Area, depth 641 metres; 66 specimens, many very small, attached to Echinoderm spines.

(ii) Sta. 111, Zanzibar Area, depth 333 metres; 1 specimen, with *V. capsula* Hoek, on a Gasteropod shell.

Diagnosis.—Shell white with patches of greenish-yellow membrane; walls nearly vertical, the fixed scutum and tergum being only slightly oblique; movable scutum and tergum with three articular ridges; movable scutum triangular, with a very deep adductor pit; movable tergum quadrilateral: rostrum patelliform with ridges extending to all margins except the basal; umbo produced and retroverted towards movable scutum; base of walls more or less inflected in parts; strong myophore pit and ridge on fixed scutum.

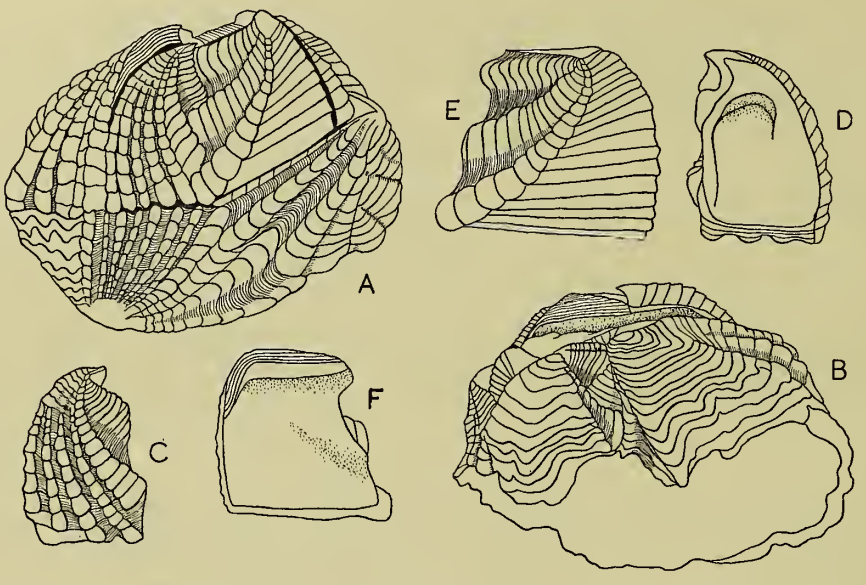
Description.—The movable scutum is triangular, with a crenulate basal margin and strongly curved occludent margin. The tergal margin is sinuous internally owing to the projection of the articular ridges. The apex is slightly inturned. Of the three articular ridges the second is the broadest; the first is comparatively large and only slightly narrower than the second, and the third (axial) ridge is narrow but very prominent. The remainder of the scutum bears three very prominent ridges, separated by deep furrows, and articulating with the rostrum.

The valve is thick with a prominent internal rim along the occludent margin. It is generally concave internally. The adductor pit is situated in the upper half of the valve.

The movable tergum has a straight basal margin, convex posterior occludent margin and slightly concave upper occludent margin. The axial ridge does not project beyond the basal or scutal margins. The apex is bent slightly towards the scutum. The three articular ridges are prominent and sharply marked off by deep furrows; the first ridge is rather narrower than the other two. The posterior half of the valve is ornamented with growth-ridges only. Internally the valve is slightly convex, more so where the valve meets the scutum near the adductor pit so that there is a conspicuous thickening of the tergum. The rostrum has four prominent sharply defined ridges articulating with the corresponding ridges on the movable scutum. Four ridges articulate with the carina, three being rounded and the lowest one flattened. The first and fourth ridges are of equal breadth and about twice as broad as the other two. In a few specimens a fifth ridge is present in this series, and all five ridges may be considerably flatter than in the specimen figured. The paries is ornamented by curved growth-lines only. The basal edge is thickened considerably and projects inwards.

The carina has its upper edge bent at a right angle. The edge abutting on the base

of the tergum makes a straight line with the corresponding scutal edge of the rostrum. The valve is indistinctly divided into two triangular portions. The largest or paries is ornamented by irregular growth-ridges which project from the surface in a number of blunt points. A small ridge, probably the ala, articulates with the fixed tergum. On the rostral side the radial area is large, and commonly bears three distinct ridges articulating with the rostrum. There may be as many as six of these ridges, in which case the lower ones are very small and often indistinctly demarcated, and do not reach far from the margin towards the umbo of the valve, which is situated in the angle of the upper margin. The basal margin is considerably inflected.



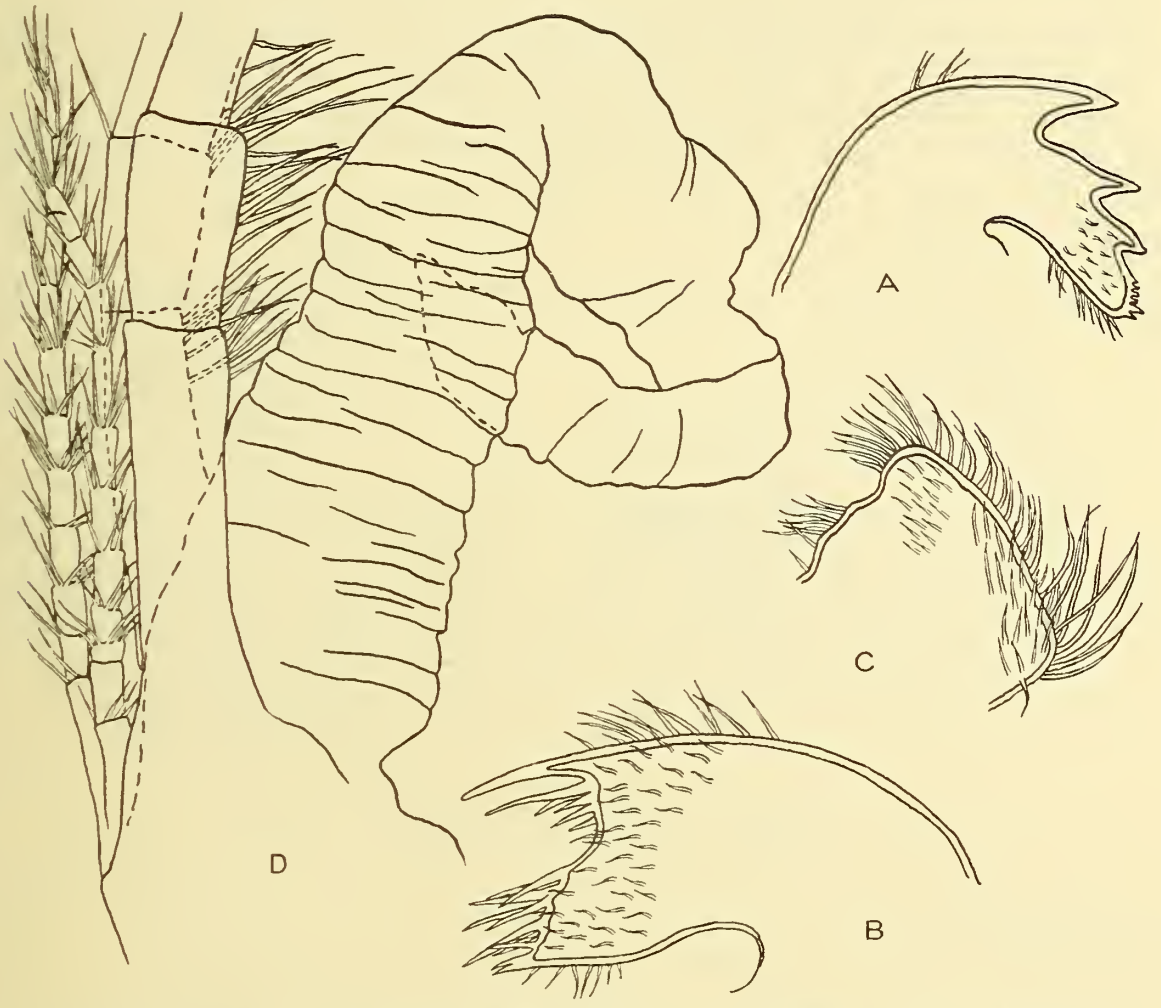
Text-fig. 15.—*Verruca sewelli* sp. nov. A, From side of movable valves. B, From side of fixed scutum and tergum. C, D, External and internal view of scutum. E, F, External and internal view of tergum. All × 30.

The fixed scutum consists of a central paries and two radii. The paries has two broad irregular ridges, or rather flutes, formed by the curving of the whole valve. The radial area on the tergal side is small and unornamented except for faint growth-lines. The rostral radial area is as big as the paries and articulates with the rostrum by five prominent ridges. Four of these are subequal in length and breadth. The fifth and lowest is slightly narrower and shorter than the others. The basal margin is not inflected, but slants obliquely inwards to the edge of the ridge forming the lower side of the myophore or muscle attachment. There is a distinct internal longitudinal groove bounded on the side away from the margin by a longitudinal ridge. The groove and ridge together form the articular surfaces joining the fixed scutum to the fixed tergum.

The fixed tergum likewise consists of three triangular portions. The paries is smooth and ornamented by growth lines. There are faint suggestions of vertical ridges. The scutal radius bears two small ridges. It does not reach the occludent margin of the valve, which is formed by the broad flat edge of the parietal portion of the valve. The umbo is removed a little from the occludent margin. The carinal radius is nearly as large as the paries, and bears a prominent marginal ridge running to the end of the occludent margin of the carina.

Internally the fixed tergum has a large V-shaped depression on either side where it articulates with the carina and fixed scutum. There is a horizontal ridge across the middle of the valve. This is the thickest part of the valve, which becomes thinner towards the upper and lower margins.

The palpus is narrow and parallel-sided with setæ on the inner edge and the tip. The terminal setæ are rather longer than the others.



TEXT-FIG. 16.—*Verruca sewelli* sp. nov. A, Mandible, × 48. B, Maxilla I, × 96. C, Maxilla II, × 48. D, Penis and caudal appendages, × 48.

The mandible has three acute teeth and a large lower lobe with six prominent small acute teeth on its anterior face. The extreme basal angle is rounded. There are a few setæ on the ventral margin of the appendage, and others on the surface at the base of the second and third teeth.

The first maxilla has a stout upper spine and a deep notch occupying all the upper half of the biting margin. In the notch are one long thin spine and four progressively shorter spines, the largest of which is only half the length of the long thin one. The lower edge of the notch is bare of spines. The lower portion of the biting edge bears four pairs of enlarged spines and then three pairs of short spines packed very closely

together at the extreme lower angle. A few paired hairs are present on the dorsal and ventral margins of the appendage.

The second maxilla is lobe-like and bears long hair-like setæ in three groups, the outer group being confluent with the terminal.

Cirrus I is situated a little removed from the next. The anterior ramus is three-fourths of the length of the posterior.

Cirrus II is similarly proportioned to cirrus I, but has a much longer protopodite.

Cirrus III has the rami equal, the anterior strongly tapered as in cirri I and II, and the posterior only slightly tapered. The protopodite is almost as long as the rami.

Cirri IV–VI have long equal rami not tapering except at the extreme ends.

The caudal appendages are eleven-segmented, and reach just above the bifurcation of cirrus VI.

The penis is very long and stout in the proximal portion. It is finely annulated throughout its length.

The following table shows the number of segments in the rami of the cirri in one of the specimens examined :

Cirrus.	I.	II.	III.	IV.	V.	VI.
Anterior ramus	12	12	15	19	21	25
Posterior ramus	13	13	15	21	23	26

Remarks.—In the partially inflected edge to the walls this species is allied to *V. nexa* Darwin, and particularly to the variety *V. nexa alba* Pilsbry (1907*b*). It differs from this subspecies in not having the apices of the fixed scutum and tergum produced into beaks, in the greater number of articular ridges uniting the rostrum and carina, and in the incomplete development of the inflected basal edges of the walls.

This species is named in honour of Lt.-Col. R. B. Seymour Sewell, sometime Director of the Zoological Survey of India and Leader of the " John Murray " Expedition.

Verruca (*Metaverruca*) *capsula* Hoek.

Verruca capsula, Hoek, 1913, p. 130, pl. xii, figs. 1–3, pl. xiii, figs. 1–4.

Occurrence.—Sta. 110, Zanzibar Area, depth 333 metres ; 3 specimens growing on a Gasteropod shell.

Remarks.—In the form and ornamentation of the walls the specimens agree very well with the description of the type. The growth-ridges are much reduced, almost to lines alone, and consequently the walls are very nearly smooth. The growth-lines are somewhat more regular than in the figure of the type. The articular folds, or flattened ridges, of the rostrum and carina vary slightly in size and number. There are five on each valve, of which two are large in two of the specimens, and three in the third specimen.

The movable tergum differs from that of the type in that there is no deep excavation in its scutal margin. Instead there are two shallow indentations almost confluent, and corresponding to two small projections on the tergal wall of the movable scutum. There is thus no large protuberance on the tergal wall of this valve. The rim on the two occludent margins of the tergum is very small and scarcely perceptible.

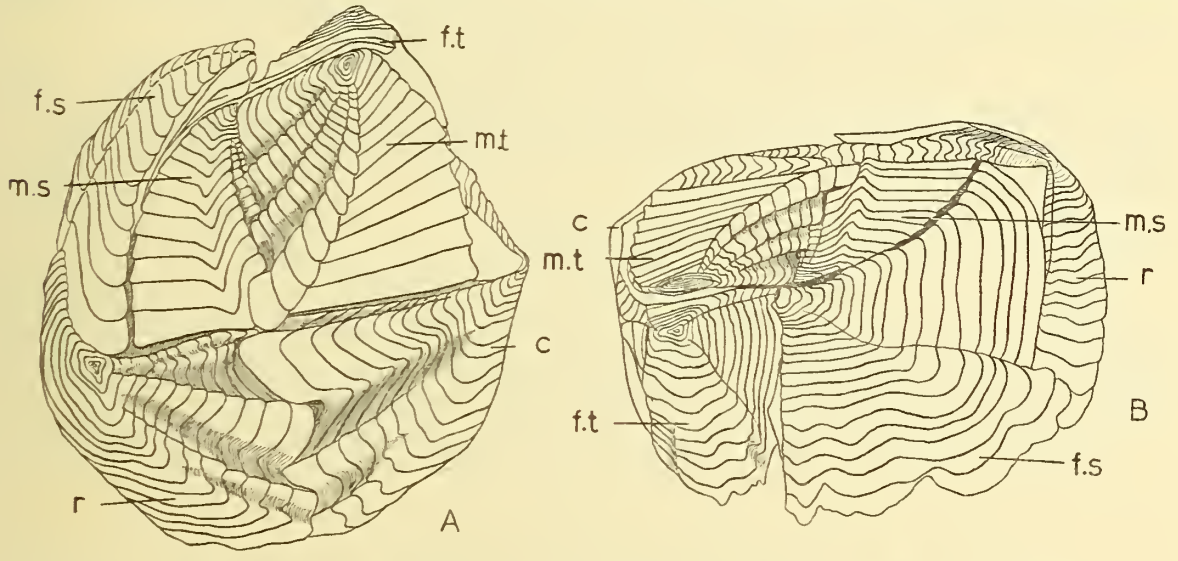
One of the three specimens shows slight indications of ridges on the post-axial part of the scutum. They are not very distinct, however, and the specimen agrees in other characters with the other two, so it is included under this species.

Verruca (*Verruca*) *macani* sp. nov. (Fig. 17.)

Occurrence.—Sta. 122, Zanzibar Area, depth 762 metres; 1 specimen, slightly damaged.

Diagnosis.—Shell white, with thin membrane adhering in grooves; basis circular: walls nearly vertical; plane of operculum parallel to basis; movable scutum and tergum with four articular ridges: remainder of these valves with growth lines only; umbo of rostrum marginal; rostrum and carina articulating by three flattened ridges; suture between fixed tergum and fixed scutum vertical, nearly straight.

Description.—The movable scutum is triangular. The opercular side is strongly convex, the articular straight except for a projection at the end of the third articular ridge. The basal margin is straight. The first articular ridge is minute, and almost



Text-fig. 17.—*Verruca macani* sp. nov. A, From side of movable valves. B, From side of fixed scutum and tergum. Lettering as in Text-fig. 14. Both figures from the type-specimen.

obscured by the small, narrow second; the third is much larger and has the upper edge sharply demarcated. The lower edge curves into the furrow between ridges 3 and 4. The fourth (axial) ridge has straight sides, and is triangular in section instead of semicircular as is more common. It is distinctly marked off from the rest of the valve.

The movable tergum is trapezoid, with the upper occludent margin parallel to the straight basal margin. The articular margin is straight except at the basal angle, where the axial ridge forms a projection. The posterior occludent margin is convex. The apex is obtuse and rounded off. The uppermost articular ridge is the broadest, and is not separated from the upper margin. The other three are subequal in width. The post-axial part of the plate is ornamented with growth ridges only.

The rostrum is shaped like a cone with a section removed. The marginal umbo lies at the junction of the fixed and movable scuta. The uppermost articulatory ridge is double and runs at the edge of the valve. The middle ridge is by far the largest. The ridges are depressed and not sharply demarcated on the lower side. The remainder of the valve is ornamented with distinct but inconspicuous growth ridges only. There are no articular ridges on the side next the fixed scutum.

The carina is rectangular, and bent medianly at rather less than a right angle. The two portions of the upper margin are straight, that nearest the rostrum articulating with the movable tergum. Three broad flat ridges, separated by shallow furrows, articulate with the rostrum. No ridges articulate with the fixed tergum, but only one irregular projecting lobe which fits into a pit on the carinal margin of the fixed tergum.

The fixed scutum is irregularly quadrilateral. The curved occludent margin is as long as, and nearly parallel to, the very irregular basal margin. The rostral margin is irregular, and runs obliquely up the side of the shell. The fixed tergal margin is nearly vertical. The apex is acute and produced. The valve is divided into two triangular portions by a line running diagonally across it from the apex. In the upper or occludent segment the growth lines are parallel to the convex portion of the rostral margin. There is a faint indication of a median ridge on this segment. The lower segment is smoother, and has less distinct growth ridges parallel to the basal margin.

The fixed tergum is divided into three triangular sections—a central paries with apical umbo and irregular growth lines, and two lateral areas. The scutal lateral portion is small and lies below the general surface of the wall; the carinal portion is nearly as large as the paries.

The internal anatomy has not been investigated, as it would have entailed the destruction of the unique specimen of this species.

Remarks.—The species is closely allied to *V. grimaldii* Gruvel (1912), obtained by the Prince of Monaco in lat. 32° 30′ 30″ N., long 17° W., at a depth of 2380 metres. It differs, however, in the movable operculum being parallel to the basis instead of oblique, and in the absence of rostral ribs articulating with the movable scutum.

The author has pleasure in naming this new species after Mr. T. T. Macan, one of the biologists on the " John Murray " Expedition.

Suborder BALANOMORPHA Pilsbry 1916.

Family *BALANIDÆ* Darwin.

This family is represented in the collection by three genera, *Balanus*, *Acasta* and *Tetraclita*, and twelve species.

Genus BALANUS Darwin.

This large and difficult genus is represented in the collection by ten species belonging to five of the subgenera proposed by Pilsbry (1916), namely, *Megabalanus*, *Balanus* s. str., *Chirona*, *Solidobalanus* and *Conopea*.

Subgenus Megabalanus Pilsbry.

Megabalanus is represented by a single species :

Balanus (*Megabalanus*) *tintinnabulum* Darwin.

Balanus tintinnabulum, Darwin, 1854, p. 144, pl. i, figs. *a–l*, pl. ii, figs. 1*a*–1*o*.
Balanus tintinnabulum, Hoek, 1883, p. 147, pl. xii, figs. 18, 19; 1913, p. 164, pl. xiv, figs. 5–7.

Occurrence.—Sta. 53, South Arabian Coast, depth 13½ metres; 6 specimens.

Remarks.—All the specimens were dead when collected and had lost the opercular valves, but they appear to be referable to this species.

Subgenus Balanus Pilsbry.

This subgenus is represented by two species :

Balanus (*Balanus*) *trigonus* Darwin.

Balanus trigonus, Darwin, 1854, p. 223, pl. iii, figs. 7*a–f*.
Balanus trigonus, Krüger, 1911, p. 49, pl. i, fig. 6, pl. iii, fig. 33, text-figs. 98–100.
Balanus trigonus, Pilsbry, 1916, p. 111, pl. xxvi, figs. 1–13*e*, text-figs. 27, 28.

Occurrence.—Sta. M.B. II (*c*). South Arabian Coast, depth 30 metres ; 1 specimen attached to a fragment of a larger *Balanus*.

Remarks.—The parietal ridges are only poorly developed, probably owing to the juvenile condition of the specimen. The scuta bear three rows of oblong deep pits.

Balanus (*Balanus*) *amphitrite* var. *communis* Darwin.

Balanus amphitrite, Darwin, 1854, p. 240, pl. v, fig. 2*a–o*.
Balanus amphitrite, Nilsson-Cantell, 1921, p. 311, text-fig. 64.

Occurrence.—(i) Sta. 111, Zanzibar Area, depth 73–165 metres ; 3 specimens attached to a piece of a dead Gorgonian skeleton and devoid of opercular valves, probably referable to this species.

(ii) Sta. 120, Zanzibar Area ; 2 specimens purporting to come from a depth of 2900 metres.

Remarks.—Both specimens from Sta. 120 are detached from their substratum and are somewhat crushed, and moreover have rust-like concretions on the basis as if they had been attached to iron. Hence it is highly probable that these specimens come, not from 2900 metres, but were scraped off the ship's hull—a common habitat of this species—during the hauling of the net.

Subgenus Chirona Pilsbry.

The subgenus *Chirona* is represented by two species, *B. amaryllis* Darwin and *B. albus* Hoek.

Balanus (*Chirona*) *amaryllis* Darwin.

Balanus amaryllis, Darwin, 1854, p. 279, pl. vii, figs. 6*a–c*.
Balanus amaryllis, Gruvel, 1905, p. 250, text-fig. 279.
Balanus amaryllis, Hoek, 1913, p. 179, pl. xv, figs. 17–21, pl. xvi, figs. 1–4.
Balanus amaryllis, Pilsbry, 1916, p. 217.

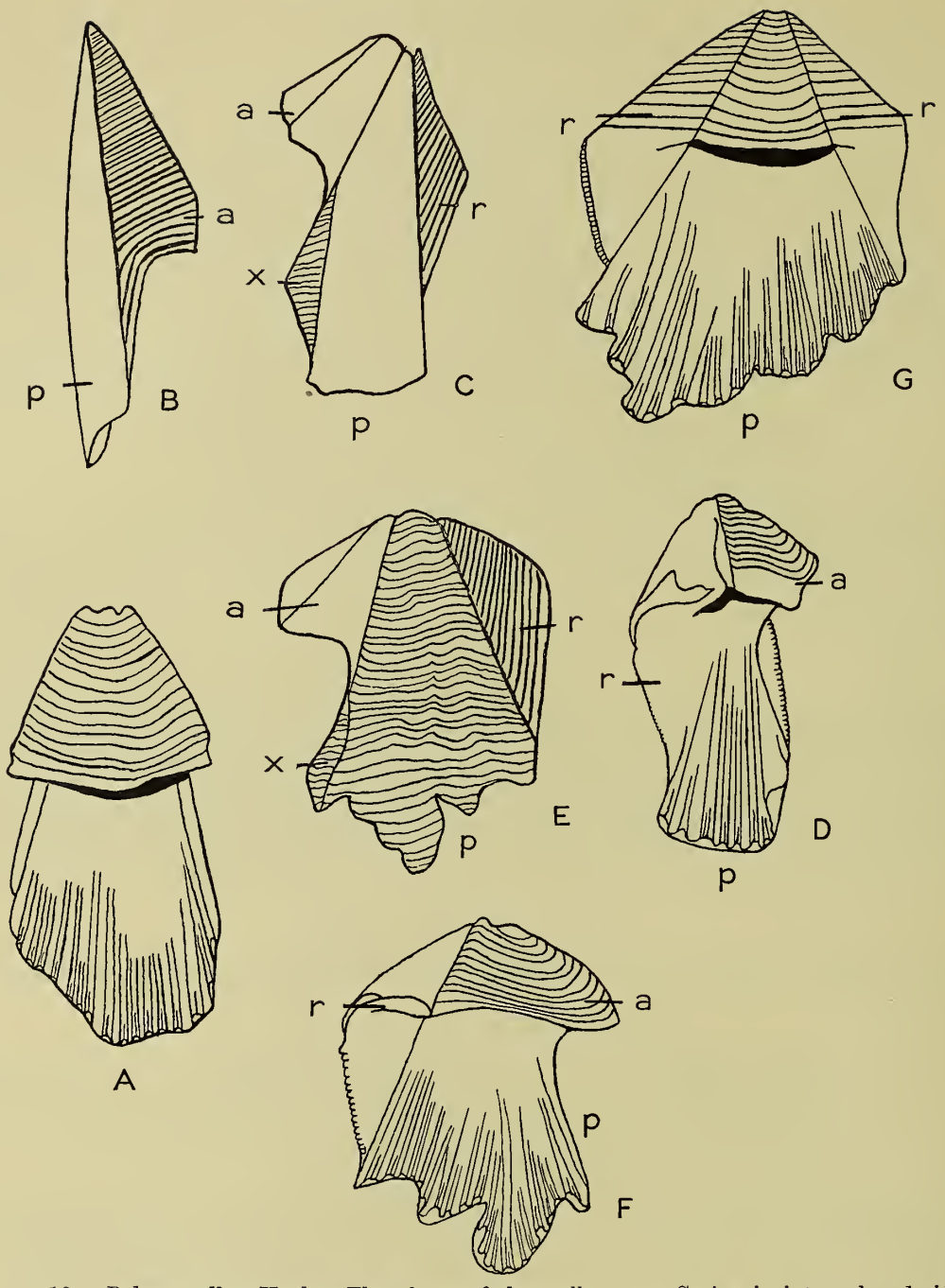
Occurrence.—Sta. 35, Gulf of Aden, depth 450 metres ; 2 living specimens from the body of the crab, *Echinoplax pungens* Spence-Bate.

Remarks.—Both are of the white variety (var. *niveus* Gruvel, 1905). Pilsbry (1916) records this species from a depth of 150 fathoms, and remarks that it has an unusually great range, occurring from the surface down to this depth ; but those specimens found by the " Albatross " from below 114 fathoms were all dead, which is somewhat peculiar when it is borne in mind that the present specimens come from over twice that depth.

Balanus (*Chirona*) *albus* Hoek. (Fig. 18.)

Balanus albus, Hoek, p. 185, pl. xvi, figs. 12, 13, pl. xvii, figs. 1–6.

Occurrence.—(i) Sta. 105, Zanzibar Area, depth 238–293 metres ; 4 living and 6 dead examples attached to a large *Buccinum*-like Gasteropod (? *Drillia* or *Pleurotoma*).



TEXT-FIG. 18.—*Balanus albus* Hoek. The plates of the wall. A, B, Carina in internal and side view. C, D, Carino-lateral in external and internal view. E, F, Lateral in external and internal view. G, Rostro-lateral and rostrum in internal view. All × $\frac{8}{3}$. *a.*, ala. *p.*, paries. *r.*, radius. *x.*, ridged part of paries, interlocking with radius of radio-lateral.

(ii) Sta. 157, Maldive Area, depth 229 metres; 18 specimens (7 living), on *Caryophyllia* spp.

(iii) Sta. 194, Gulf of Aden, depth 220 metres; about a dozen specimens, half of which were dead, attached to Gasteropod shells, probably *Pleurotoma* sp., which also bore specimens of a small anemone and occasionally smaall sponge.

REMARKS.—Of the specimens from Sta. 105 only two, one of which was dead, are

approximately full-sized. The vertical ribs on the parietes are distinct, and on the large dead example traces of the growth ridges can be made out.

A number of other specimens, attached to pieces of clinker, from this station, are also referred to *B. albus*, though with considerable hesitation, as they are far less typical than the above specimens. In the parietes the growth lines are almost invisible except for occasional traces on the older specimens, and the vertical ridges are all but absent. The walls, however, are probably the most variable part of a *Balanus*, and so too much weight must not be put on this character. The scutum and tergum are very typical. As in the previously mentioned specimens, the basis is porous throughout, a character concerning which Hoek (1913) was doubtful in his diagnosis, and which Pilsbry (1916) was unable to settle for lack of fresh material.

Subgenus Solidobalanus Hoek.

This subgenus is represented by three species, two of which, *B. thompsoni* and *B. echinoplacis*, must be regarded as new.

Balanus (*Solidobalanus*) *ciliatus* Hoek.

Balanus ciliatus, Hoek, 1913, p. 199, pl. xix, figs. 8–16.

Occurrence.—(i) Sta. M.B. I (*d*), Red Sea, depth 26 metres; 1 specimen attached to a piece of sponge-like substance.

(ii) Sta. 24, Gulf of Aden, depth 73–220 metres; several specimens.

Remarks.—In the Red Sea specimens the basis is elongated and wrapped round as if to clasp a cylindrical support, only a portion of which is left as the spongy tissue in the trough formed by the basis. The radii are orange-pink and the parietes reddish, darker towards the base of the compartments, with red stripes on the upper part merging into the completely red basal part of each compartment. The carina is pinkish-white with four vertical red lines.

The articular ridge of the scutum is rather more prominent than described and figured by Hoek. The mandibles and maxillæ agree with the figures of the type-specimen.

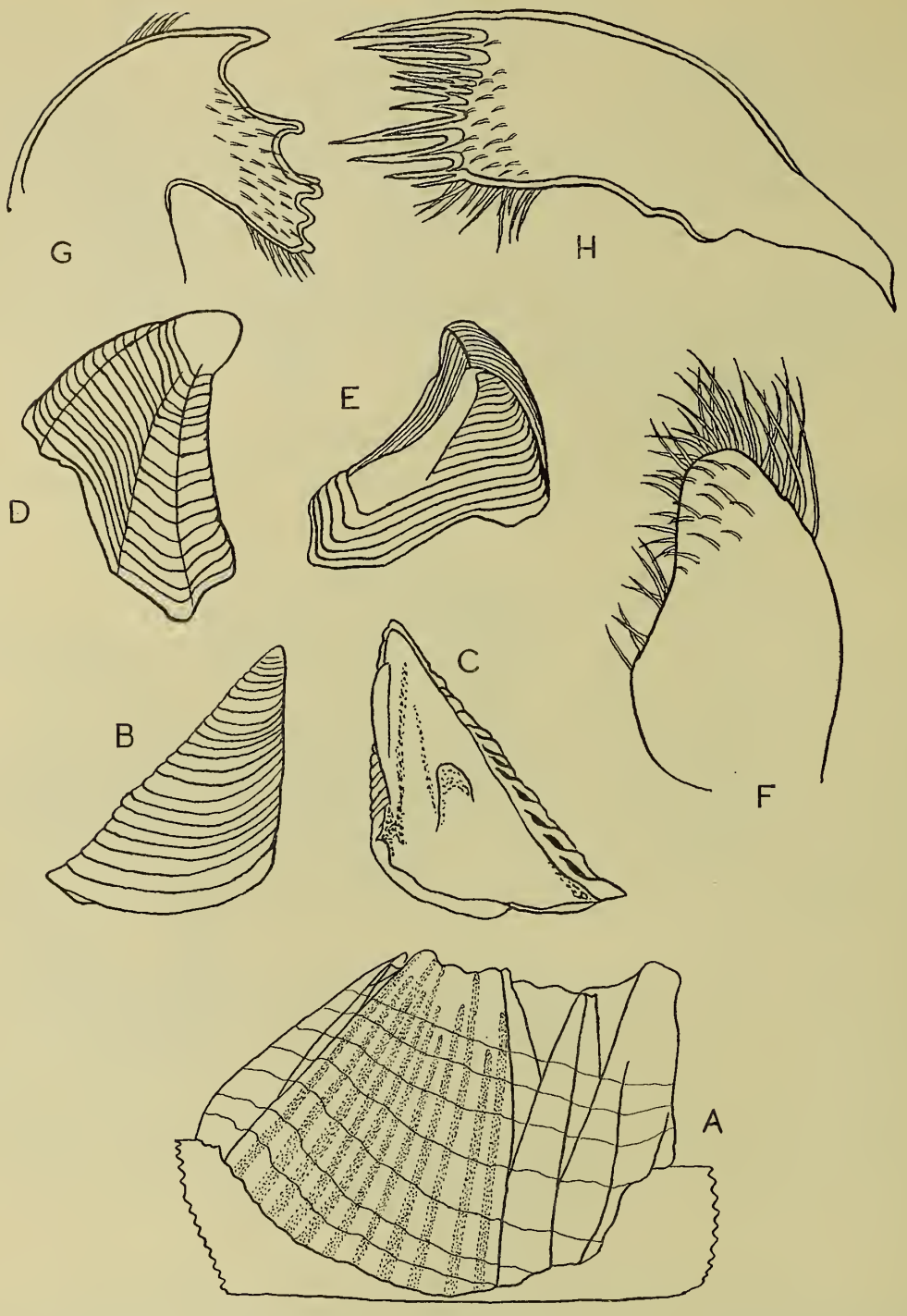
The specimens from the Gulf of Aden were attached to a hydroid that was encrusted with Foraminifera, a Stylasterine, Polyzoa, sponges, etc. Of about a dozen specimens, at least half were dead. The majority of the specimens are of the normal pale pinkish-red colour, partly white, and with vertical red stripes and an orange tinge on the radii and parts of the parietes. One specimen, however, like that from Sta. M.B. I (*d*), is orange-red all over with deep red vertical lines on the parietes.

Balanus (*Solidobalanus*) *thompsoni* sp. nov. (Fig. 19.)

Occurrence.—Sta. 24, Gulf of Aden, depth 73–220 metres; 1 specimen.

Diagnosis.—Test white; basis calcareous and non-porose, internally radially ribbed; parietes of rostrum, lateral and carina, broad; of carino-lateral, narrow; radii very narrow with very oblique summits; orifice pear-shaped; apices of parietes truncated and slightly toothed; scutum triangular, basal margin convex; tergum with very small, broad spur, with obliquely truncated end; apex acute and reflected over scutum; mandible with five teeth and no ventral lobe; third tooth double.

Description.—The basis is roughly circular and the test forms a smooth regular cone. No longitudinal ridges or growth ridges are visible externally, the only irregularities



TEXT-FIG. 19.—*Balanus thompsoni* sp. nov. A, Type-specimen, × 20. B, C, Scutum in external and internal view, × 30. D, E, Tergum in external and internal view, × 30. F, Palpus. G, Mandible. H, Maxilla I. All × 48.

being shallow furrows between the parietes where lie the very narrow radii. The summits of the alæ are nearly parallel to the basis. The parietes have a slightly concave upper margin with a tooth at either corner, and sometimes two smaller teeth between these formed by the upper ends of internal ridges. They are non-porose and internally furrowed.

The scutum has straight occludent and tergal margins. It is ornamented externally

by regular growth ridges. There is a large articular ridge. The adductor ridge is poorly developed except below the articular ridge, where it forms a definite side to the deep triangular pit for the adductor muscle. The depressor pit is small but distinct.

The tergum has a convex occludent margin and strongly concave scutal margin. The obliquely truncated spur curves into the basal margin on the scutal side. The other side is straight and forms a wide angle with the basal margin. Internally there is a strong articular ridge running from the apex to the tip of the spur.

The palpus is oval and concave on the inner margin, which bears short, stout and somewhat strongly curved setæ.

The mandible has five teeth, the third being double. There is no ventral lobe. There are spines on the ventral margin as in all species of the subgenus *Solidobalanus*.

The first maxilla has a very small notch and two large upper spines. There are two enlarged spines on the lower portion of the margin, and a number of pairs of stiff setæ on the ventral margin.

The second maxilla bears numerous hairs on the short, broad outer lobe. The hairs on the outer margin of this lobe are very long. The inner lobe is semicircular with very few hairs.

Cirrus I : Anterior ramus twice as long as posterior.

Cirrus II : Rami subequal, both shorter than anterior ramus of cirrus I and nearly straight. The segments are rather broader than long.

Cirrus III : Rami subequal, the posterior slightly the longer. The segments are broader than long and somewhat flattened.

Cirri IV–VI : Rami long and curved and subequal. The segments are cylindrical and longer than broad.

The following table gives the number of segments in the cirri :

Cirrus.	I.	II.	III.	IV.	V.	VI.
Anterior ramus . . .	8	9	12	15	17	21
Posterior ramus . . .	15	9	9	17	21	21

There is no penis.

Remarks.—*B. thompsoni* is closely related to *B. ciliatus* Hoek (1913), *B. socialis* Hoek (1913) and *B. hawaiensis* Pilsbry (1907), all of which possess five mandibular teeth. The other species of the subgenus, *B. maldivensis* Borrodaile (1903), *auricoma* Hoek (1913), *compressus* Hoek (1913) and *tantallus* Pilsbry (1907*b*), have only three or four mandibular teeth and a lower lobe with a dentate edge. Of the three nearest, *B. hawaiensis* lacks the double third mandibular tooth and so is readily distinguished : *B. ciliatus* has broad radii, and so is quite distinct in external features alone. There are other small differences in the appendages, *e. g.* the fifth mandibular tooth is distinct from the lower angle, but is blunt and rounded like the lower lobe ; this tooth is similar in *B. socialis*, where the third tooth is single, thus distinguishing this species from the new *B. thompsoni*.

This species is named after Mr. E. F. Thompson, one of the scientists of the " John Murray " Expedition.

Balanus (*Solidobalanus*) *echinoplacis* sp. nov. (Fig. 20.)

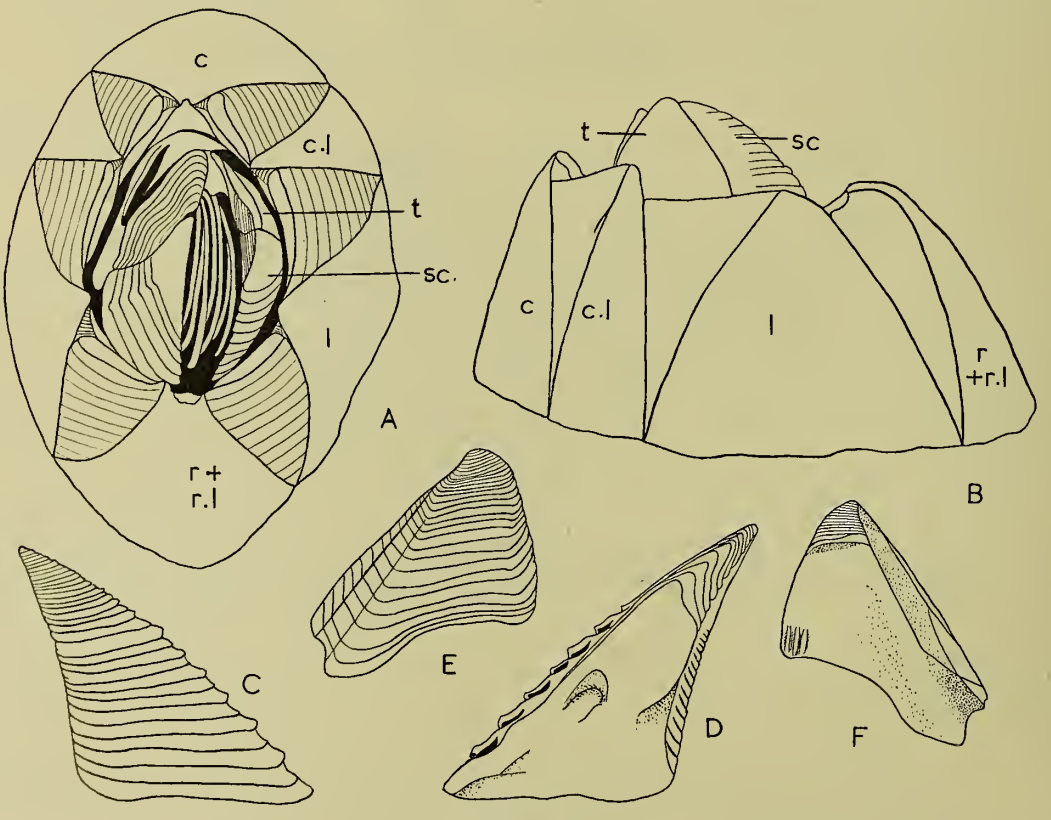
Occurrence.—Sta. 106, Zanzibar Area, depth 225 metres ; 48 specimens attached to a crab, *Echinoplax pungens* ; 31 specimens were left *in situ*.

Diagnosis.—Solid, thick-shelled balani with smooth shiny parietes and radii; parietes without striæ or distinct growth lines; radii broad with horizontal markings in the texture of the shell; summits of radii nearly parallel to basis; articular edges ridged; alæ large, but hidden by radii except at the upper angle; summits of alæ very oblique; scuta with distinct growth ridges and occasional fine intervening lines; apex slightly retroverted towards tergum; adductor pit distinct; tergum with poorly developed depressor ridges.

Description.—The form of the shell is circular, or more often oval when attached to Crustacean limbs. It is chalky white and absolutely smooth and devoid of growth lines or ridges, except in the case of one old and distorted specimen, in which three short ridges occur on one lateral paries. The parietes have acute apices, that of the rostrum curving inwards. The basis is porose with radiating canals. It is firmly attached to the Crustacean and fairly thick. The canals are large. A few regular ridges occur on the inner surfaces of the parietes. The orifice of the shell is oval, and the opercular valves project above the surface of the shell.

The scutum is triangular. The basal margin is slightly sinuous, the occludent weakly convex and toothed, and the tergal margin slightly concave. The growth lines appear as distinct grooves demarcating successive incremental areas. Alternate areas have large and small teeth on the occludent margin. The articular ridge is very prominent, the adductor ridge scarcely indicated as a convex area at the lower end of the articular ridge.

The tergum is roughly triangular, with convex carinal margin and straight scutal margin. The scutal margin is twice bent so as to form a distinct ridge, triangular in



Text-fig. 20.

section, along the scutal margin. There is no spur furrow. The spur is short and truncated with the sides curving into the basal margin. The apex of the valve is rounded, and very slightly retroverted towards the scutum. The articular ridge is prominent, with a distinct groove between it and the edge of the valve which forms a second ridge. There are small and indistinct ridges for the attachment of the depressor muscles.

The palpus is almost rectangular, not tapering, with short setæ on the inner edge and a dense tuft of longer setæ at the distal extremity.

The mandible bears four teeth, the lowermost being blunt and the others acute. There are three teeth on the inferior lobe, the lower two being very minute. There is a row of spines on the ventral edge and a few hairs on the dorsal.

The first maxilla has two large upper spines. There is a very small notch with one short spine, and below this four large spines followed by about six small ones on the lower angle.

The second maxilla has a conical outer lobe, thickly coated with hairs on the outer margin. The inner lobe is minute and rounded with very few hairs.

The rami of all the cirri except the first are subequal in length. The first cirrus is not separated from the succeeding five. The rami of cirrus I are very unequal, the long anterior ramus consisting of thirteen, the shorter posterior ramus of eight segments.

The penis is very long and finely annulated.

Text-fig. 20.—*Balanus echinoplacis* sp. nov. A, Dorsal, B, lateral view of type-specimen. C, D, Scutum in external and internal view. E, F, Tergum in external and internal view. G, Palpus. H, Mandible. J, Maxilla I. K, Maxilla II. *c.*, carina. *c.l.*, carino-lateral. *l.*, lateral. *r.* + *r.l.*, rostrum + rostro-laterals. *sc.*, scutum. *t.*, tergum.

The specimens show considerable variation in the precise shape of the shell, some being very much steeper than others, with the orifice quadrilateral.

The majority of the specimens average about 8·5 mm. in the long axis, by 6·0 mm. in the short axis. There are numerous young specimens about 2·0 × 3·0 mm. The largest specimen measures 13·0 × 8·0 mm.

Remarks.—*B. echinoplacis* is nearly related to *B. astacophilus* Barnard and *B. hawaiensis* Pilsbry, both of which possess growth ridges and fine intervening lines rather more distinct than in this species. In *B. astacophilus*, moreover, the basis is ribbed, not porose as in the present species, and the alæ are only slightly oblique, whereas the present species has very oblique alæ. *B. hawaiensis* has level, horizontal alæ.

Subgenus Conopea Say.

This subgenus is represented by two species, *B. cymbiformis* Darwin and *B. navicula* Darwin.

Balanus (*Conopea*) *cymbiformis* Darwin.

Balanus cymbiformis, Darwin, 1854, p. 221, pl. iii, figs. 5*a*, 5*b*.

Occurrence.—(i) Sta. 27, Gulf of Aden, depth 27–92 metres; 7 small specimens about 4·5 mm. in length, from a finely-branched Antipatharian.

(ii) Sta. 35, Gulf of Aden, depth 453 metres; 8 specimens from a similar Antipatharian.

Remarks.—The specimens from Sta. 27 have the scutal and carinal margins of the tergum meeting at less than 90°. The tergum thus resembles, to some extent, that of *B. calceolus* Ellis. In the examples from Sta. 35 the majority have the angle between these sides of the tergum approximately 90°, and are typical *B. cymbiformis*.

Balanus (*Conopea*) *navicula* Darwin.

Balanus navicula, Darwin, 1854, p. 221, pl. iii, figs. 6*a–d*.
Balanus navicula, Hoek, 1913, p. 223, pl. xxii, fig. 26, pl. xxiii, figs. 1–3.

Occurrence.—Sta. 24, Gulf of Aden, depth 73–220 metres; 1 specimen, lacking opercular valves.

Remarks.—The specimen is covered with the light brown horny skeleton of the Antipatharian on which it grew, completely obscuring the purple hue of the barnacle itself. The shell is only slightly elongated.

Genus ACASTA Leach.

This genus is represented by a single species found embedded in a sponge. The species is—

Acasta cyathus Darwin.

Acasta cyathus, Darwin, 1854, p. 312, pl. ix, figs. 3*a–c*.
Acasta cyathus, Annandale, 1906, p. 144.

Occurrence.—Sta. M.B. I (*c*), Red Sea, depth 24 metres; 2 specimens, one of which is practically full-sized.

Remarks.—The larger specimen is about as broad as long, but the smaller one is considerably elongated. Both are of a deep pink colour. Both specimens are dead, having been buried in the sponge which fills the shell cavity.

Genus TETRACLITA Schumacher.

This genus is represented by—

Tetraclita porosa var. *communis* Darwin.

Tetraclita porosa var. *communis*, Darwin, 1854, p. 329, pl. x, fig. 1*a*.
Tetraclita squamosa, Pilsbry, 1916, p. 249.
Tetraclita squamosa var. *stalactifera*, *idem*, p. 254, pl. lix, figs. 1–5*b*.

Occurrence.—Hallaniya Island, Kuria Muria group, Arabian Sea; about 6 specimens growing upon one another, apparently broken off from a larger colony of the species.

Remarks.—The colony was growing near high water mark. Associated with it are numerous small specimens of *Chthamalus stellatus* (Poli).

Family *CHTHAMALIDÆ*.

Chthamalus stellatus (Poli).

Chthamalus stellatus, Darwin, 1854, p. 455, pl. xviii, figs. 1*a–h*.
Chthamalus stellatus, Weltner, 1897, p. 443.

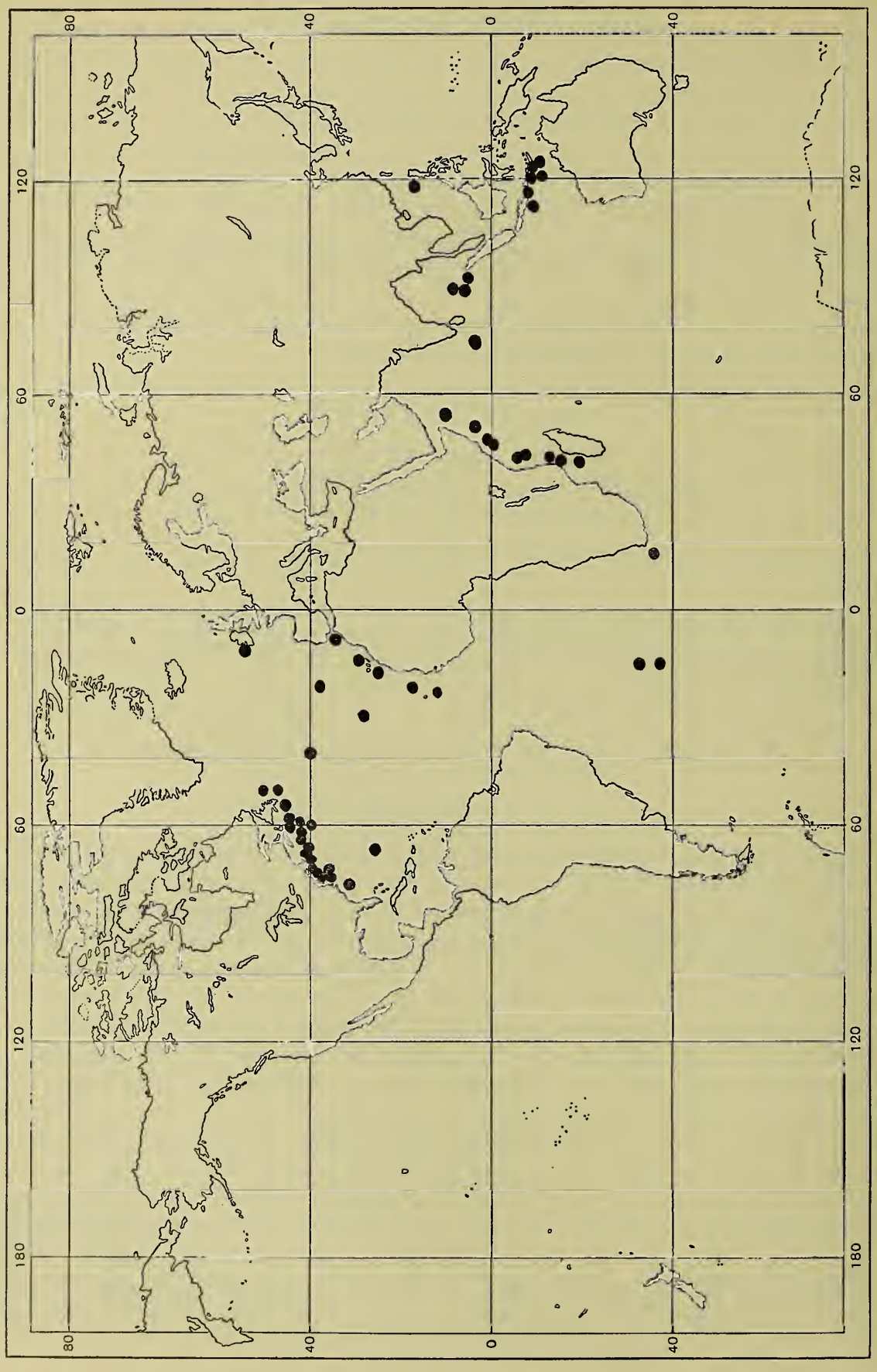
Occurrence.—Hallaniya Island, Kuria Muria group, Arabian Sea; numerous specimens.

Remarks.—A number of small specimens were obtained attached to the group of specimens of *Tetraclita porosa* mentioned above. The specimens are quite typical, but are almost certainly young.

THE DISTRIBUTION OF SOME SPECIES OF *SCALPELLUM*.

1. Geographical.

Any attempt at an account of the geographical distribution of the species of *Scalpellum* is necessarily hampered by the very sketchy nature of our knowledge of even a single species of the scores now known to science. This lack of knowledge is due mainly to the very few records that are available for any particular species, owing to the difficulty of obtaining animals from great depths without elaborately equipped vessels. From such records as we have, however, it would appear that a few species are almost world-wide in their distribution. *Scalpellum velutinum* is one of the better-known examples of a world-wide form. Fig. 21 shows the distribution of this species. The frequency of occurrence in a few areas, *e. g.* Altantic coast of N. America, is due largely to the greater detail in which such areas have been worked. It does not necessarily prove that the species is exceptionally abundant in these areas. The records of the species from the Atlantic seaboard of N. America are due to the intensive investigation of this area, extending over several years, by the U.S. Fisheries research vessel " Albatross ". The little cluster of records from the area about Madeira and the Cape Verde Islands is, again, due to the fact that this area has been worked by several research vessels, namely, the " Travailleur ", " Talisman ", and those of the Prince of Monaco. A third group of records occurs in Malaya, where the " Siboga " Expedition worked certain areas



TEXT-FIG. 21.—Distribution of *Sc.* (*Scalpellum*) *velutinum* Hoek.

in some detail. A number of records are available for the East coast of Africa, especially north of Zanzibar, where several vessels in the past and latterly the "John Murray" Expedition have operated. Other records of the species are more or less isolated, largely owing to the incomplete working of the areas by earlier expeditions. Thus the "Challenger" obtained *Sc. velutinum* at two stations in the neighbourhood of Tristan d'Acunha, but did not make another station anywhere near.

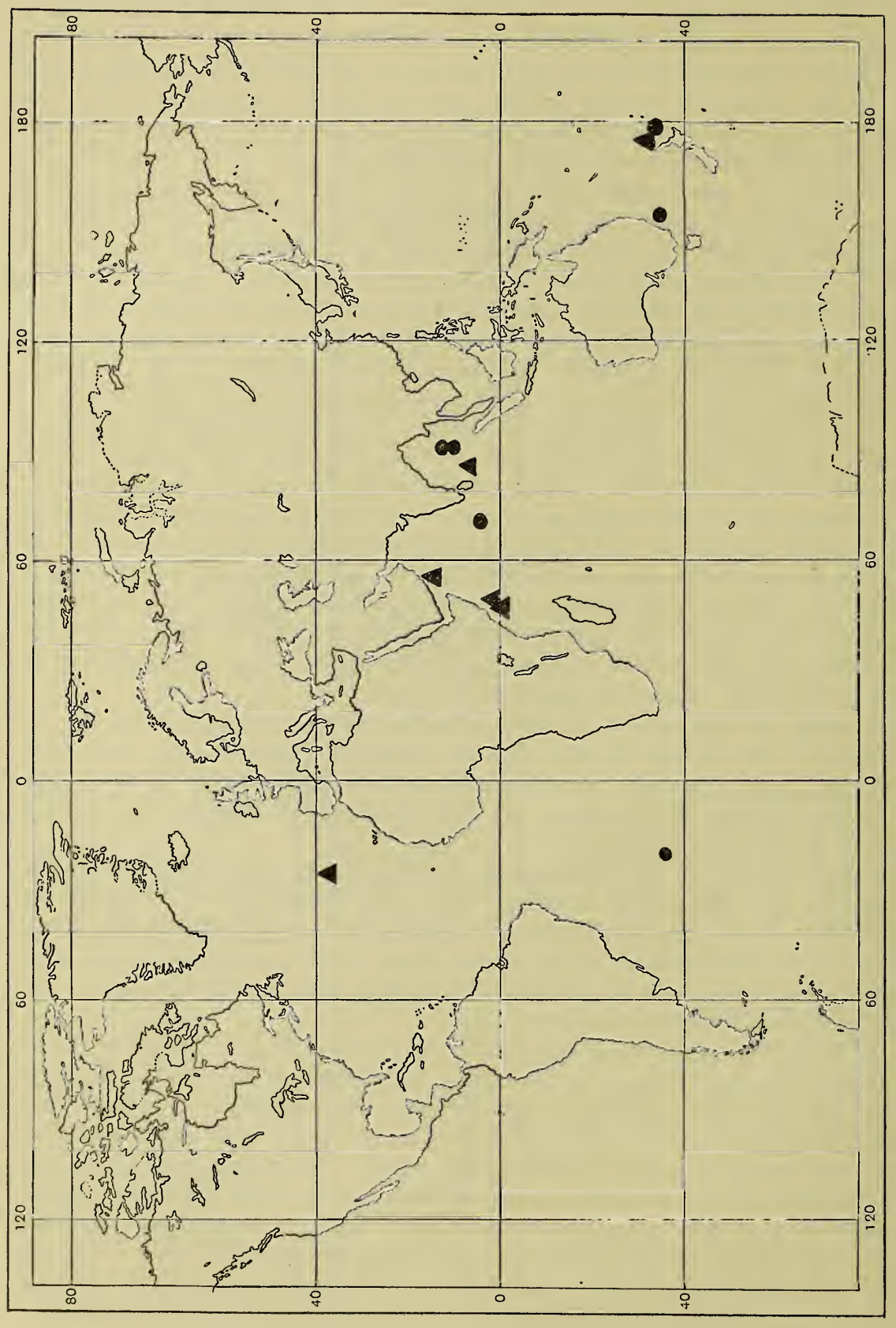
The species has been recorded as far north as lat. 51° 22′ N. (Annandale, 1911), but nowhere else in the extreme North Atlantic, except Newfoundland. The northward extension of the species to the British coast can probably, be attributed to the northward flow of the Gulf Stream, which bathes the Irish coast in particular. In fact the whole known distribution of *Sc. velutinum* in the North Atlantic lies on the course of the Gulf Stream. Only very little of this current penetrates the English Channel, and it is fairly safe to assume the absence of this species from this locality, as this has been worked in very considerable detail by the Plymouth Marine Biological Station without a single specimen being brought to light. The species also appears to be absent from the North Sea, but it is quite probable that it may yet be recorded from the neighbourhood of Iceland and Greenland, as the Gulf Stream would carry the planktonic larvæ to the east coast of Iceland, and another branch of the same current to the west coast of Greenland.

South of the equator the known limit of the species is about 40° S., specimens being recorded from Tristan d'Acunha and off the Cape of Good Hope. It is probable that this is the true southern limit of the species, as approximately in this latitude the warm sub-tropical water meets the northerly flow of the cold antarctic water, this latter dipping down under the warmer water to reach the bottom. Hence here the bottom water is probably too cold for the species to develop.

The rarity of this species in the Laccadive Sea is rather significant; the "Investigator" has trawled in this area on numerous occasions (some forty-five), and yet the species has only been obtained once at "Investigator station" 232, lat. 7° 17′ 30″ N., long. 76° 59′ 30″ E. It also appears to be completely absent from the Bay of Bengal and Andaman Sea.

The other large gap in the distribution of *Sc. velutinum*, namely, the southern Indian Ocean and the vast expanse of the Pacific, can probably be ascribed to the unexplored nature of these oceans. One may feel confident that when they are explored, this species will be shown to occur certainly in the Indian Ocean down to about 40° S., and most probably in the Pacific, as it has already been recorded from the extreme west of this latter ocean in the Philippine Islands.

It is interesting to note that geographically the distribution of *Sc. velutinum* can be divided into two main regions—(1) the Malay Archipelago, Indian Ocean and South Atlantic, and (2) the North Atlantic. The two regions are separated by the whole of the Tropical Atlantic from the Cape Verde Islands to a little to the north of Tristan d'Acunha. The two areas belong to separate ocean current systems. The Indian Ocean distribution can be explained by the alternating monsoon drifts and the south equatorial current. The Agulhas current would carry the species southwards as far as the Cape of Good Hope. Hence, the distribution of the species into the South Atlantic could only occur by the northerly flowing Benguela current, which, however, is a much cooler current formed by the mingling of water from two easterly currents, the warm South Atlantic current and the more southerly cold Antarctic current.



TEXT-FIG. 22.—Corresponding distribution of the two species *Sc. elongatum* Hoek and *Sc. novæ-zelandiæ* Hoek.
Sc. (Scalpellum) elongatum ● *Sc. (Scalpellum) novæ-zelandiæ* ▲

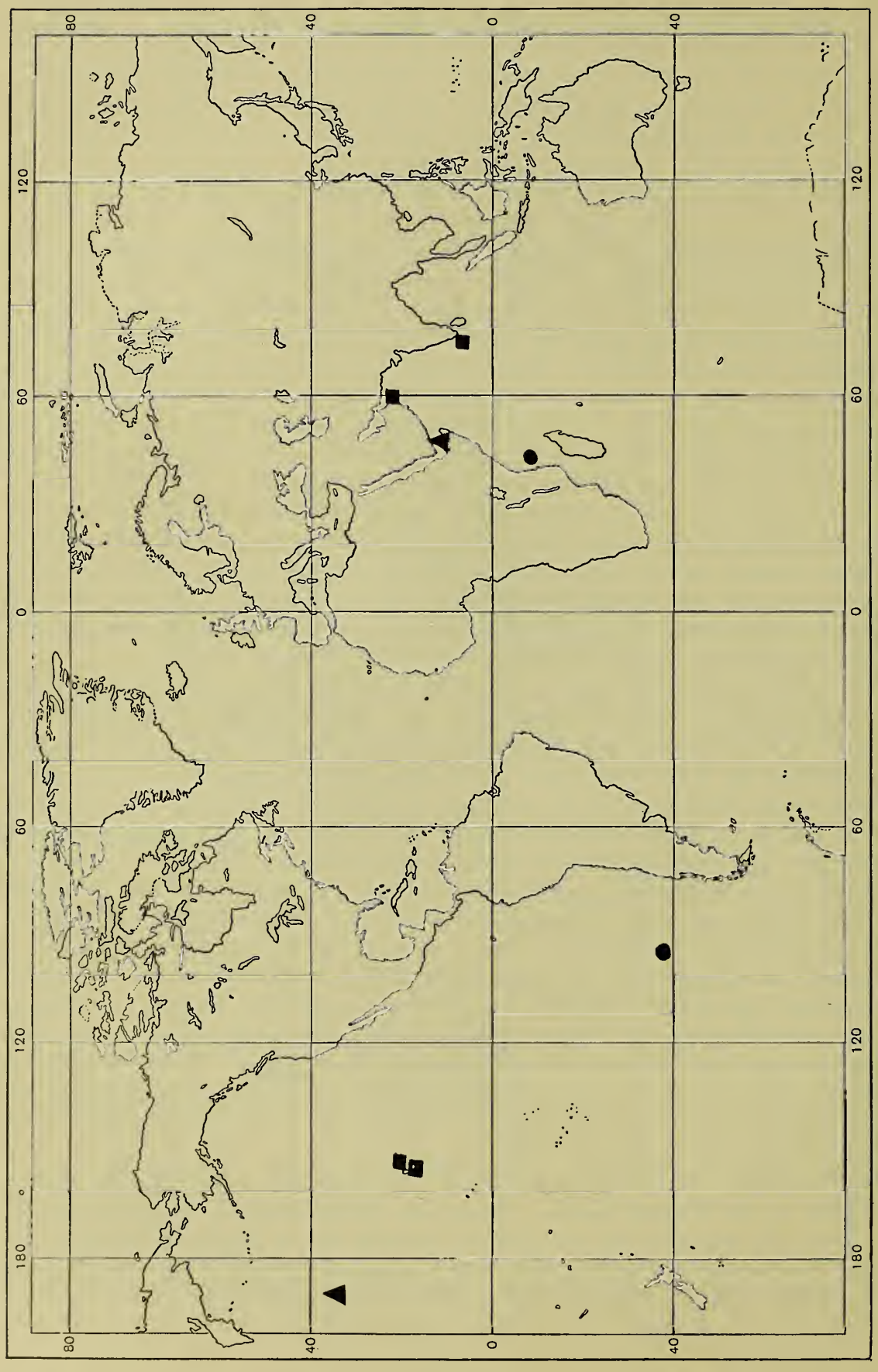
The problem is, how does a planktonic animal get transferred from the Agulhas current to the Benguela current, since the bulk of the former turns southwards over the Agulhas Bank and then flows back eastwards ? Meisenheimer (1905) has propounded a theory of a " Südafrikanisches Mischgebiet " to the south-west of the Cape of Good Hope, but very definitely excludes the warm Agulhas current from this mixing on his chart (*ibid.*, Karte IX). However. Gerhardt Schott (1926, p. 105) gives a chart of the Cape of Good Hope and Aulghas Bank in which he indicates a branch of that current swinging round the Agulhas Bank and flowing in a north-westerly direction. In a later publication the same author (1935. p. 234) says of the Agulhas current : " Ein kleinerer Prozentsatz gelangt in höchst eigenartiger Weise südlich von den Agulhas-Bank und auch über die Bank hinweg am Kap der Guten Hoffnung entlang hinaus in den Atlantischen Ozean, gegen die während vieler Monate an der Südspitze Afrikas herrschenden Westwinde fliessend. Dass dies der Fall ist, dass er in dieser Weise sich als Druckstrom nach Westen durchsetzt, kan nur durch seine vom Indischen Ozean mitgebrachte gewaltige Energie erklärt werden." Gerhardt Schott here publishes two detailed charts of this current for the southern winter (*ibid.*, fig. 64) and southern summer (*ibid.*, fig. 65), in which this north-westerly branch can clearly be followed.

Hence, we have a direct, though small, current link between the two oceans by which inhabitants of the Indian Ocean may be transferred to the Southern Atlantic. This north-westerly current would carry the pelagic animals into the Benguela current and so northwards into tropical waters again, and at its northern end into the south equatorial current of the Atlantic. From here the species could be carried southwards again by the Brazil stream and would ultimately reach Tristan d'Acunha.

The North and South Atlantic current systems are connected by a considerable north-westerly current, part of the South-East Trade or South Equatorial current, flowing up the North-East coast of South America and joining with the North Equatorial current before entering the West Indian area. It is highly probable that this was the line of extension of the distribution of *Sc. velutinum* into the North Atlantic, but at present there is nothing to prove conclusively that the species can exist in this immense intermediate zone, and it has not been recorded from the Sargasso Sea.

No other species is known from so many localities. A number, however, are known from widely separated stations, and it seems probable that these stations may one day be linked up by further discoveries consequent upon the more thorough investigation of the oceans. *Sc. elongatum* Hoek will illustrate the point. It is known from Auckland, New Zealand ; off Sydney, Australia ; the Bay of Bengal ; the Maldive Archipelago ; and one isolated station off Tristan d'Acunha. This distribution strikingly coincides with that of *Sc. novæ-zelandiæ* Hoek, which has been recorded from very similar localities. The distribution of this latter species differs in that it has not been recorded from Sydney, Tristan d'Acunha or the Maldives, but it occurs in the Gulf of Aden (Fig. 22), off Portugal and on the East African Coast.

This widespread distribution may possibly be explained by assuming a centre of distribution in the Western Pacific. Thence the Pacific Southern Equatorial current would carry the species to the east coast of Australia and to the North Island of New Zealand, but perhaps not to the South Island, where it is possible that conditions are unfavourable for the two species, owing to the cold Antarctic currents round that island. Part of the Southern Equatorial current, flowing through the East Indies, would carry



TEXT-FIG. 23.—Distribution of *Sc. pacificum* Pilsbry, *Sc. minutum* Hoek, and *Sc. abyssicola* Hoek.
Sc. (Scalpellum) pacificum ■ *Sc. (Scalpellum) minutum* ● *Sc. (Scalpellum) abyssicola* ▲

the species into the Indian Ocean, where their further distribution would take place in a manner similar to that put forward for *Sc. velutinum*.

Scalpellum minutum is a species offering a problem in distribution that appears insoluble in the present state of our knowledge. It was first obtained by the " Challenger " off Chili in lat. 42° S. Since that date it has not been found until recorded by the present expedition from off Zanzibar.

The conditions of life in these two widely separated areas are somewhat different, though both regions are cooled by cold antarctic water. The Chilean specimen was obtained at a depth of 1450 fathoms (2677 metres), and a temperature of only 1·5° C., whereas the present specimen comes from less than a third of that depth, 802 metres, and a bottom temperature of 7·8° C. Despite the somewhat big difference between them, the two sets of conditions would indicate that *Sc. minutum* is a species that inhabits cold waters.

There are two possible explanations of the distribution. It may be that this is an East Indian species that has spread westwards across the Indian Ocean, and eastwards across the whole width of the Pacific Ocean to the American coast. In the unlikely event of this being true, it is curious that *Sc. minutum* was not obtained either by the " Siboga " Expedition to the East Indies, or by Mortensen's expeditions to Australia and the Pacific. Moreover, such a line of distribution argues a species capable of living at a comparatively high temperature, of which we have no evidence, the available data all pointing to a low temperature.

The other alternative is to assume that *Sc. minutum* is an Antarctic form that has spread northwards along the northerly antarctic currents. This would fit in with the known temperatures at which the species was collected, and with the known movements of the antarctic bottom water : the cold Peru current, flowing up the west coast of South America, and the bottom current that flows northwards between Madagascar and the Seychelles, overlain by the oppositely moving Agulhas current, and traces of which can be found as far north as Mombasa.

From examples such as this one cannot but feel that the true deep-sea species of *Scalpellum* are extremely hardy and can stand a considerable range of temperature. In particular must this be true of the larvæ for, being planktonic, they doubtless experience greater variations of temperature than the bottom-living adults which inhabit a region where conditions remain almost constant throughout the year.

Scalpellum abyssicola is only known from the Gulf of Aden and the Pacific Ocean east of Japan. Here again we can only surmise that it occurs in the intervening area, but has not yet been recorded there. If this should be so it is remarkable that it has not been found in the Arabian Sea or Bay of Bengal, both of which areas have now been thoroughly worked. The species has apparently a large vertical range in deep water, so there is no apparent reason for its absence from at least the deeper parts of the above areas.

One other species, for which widely separated localities are known, is represented in the present collection. *Sc. formosum* was first described from Malayan specimens, and is at present known also from Zanzibar and from Cape Hatteras on the Atlantic coast of North America. Once again we have to invoke the aid of Meisenheimer's " Südafrikanisches Mischgebiet " and the Agulhas current to provide a means of entry into the Atlantic Ocean of an Indian Ocean species.

TEXT-FIG. 24.—Distribution of *Sc. albatrossianum* Pilsbry and *Sc. formosum* Hoek.
Sc. (Scalpellum) albatrossianum ● *Sc. (Scalpellum) formosum* ▲

Besides these widespread species of *Scalpellum* there are in the Indian Ocean a considerable number of species, not less than sixteen, that are known only from this ocean and the Malay Archipelago.

In the following list I have classified the known Indian species into four groups based on their areas of distribution as at present known :

(1) Indian Ocean and Malay Archipelago only :

Smilium kampeni.
Euscalpellum bengalense.†
E. rostratum.
E. squamuliferum.
Scalpellum alcockianum.
Sc. annandalei.
*Sc. curiosum.**
Sc. diota.
Scalpellum elegans.
Sc. gruvelii.
Sc. laccadivicum.
Sc. lambda.†
Sc. longius.
*Sc. sociabile.**
Sc. trapezoideum.
Sc. wood-masoni.†

(2) Indian and Pacific Oceans :

Scalpellum abyssicola.
Sc. minutum.
Sc. pacificum.

(3) Indian Ocean and North Atlantic :

Smilium acutum (also in Australasia).
Scalpellum albatrossianum.
Sc. formosum (and off Japan, Nilsson-Cantell, 1921).

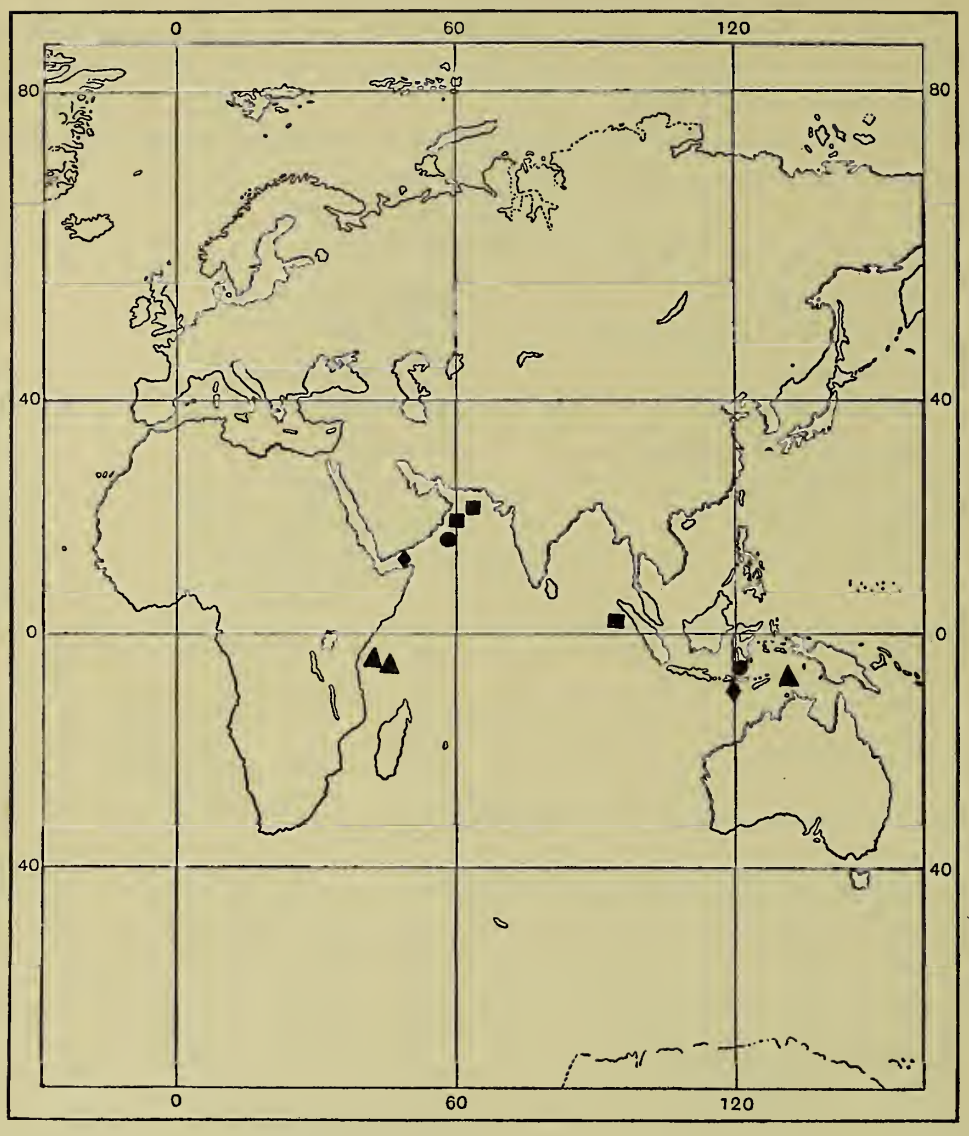
(4) Indian Ocean, South Atlantic and Australasia :

Scalpellum clongatum.
Sc. novæ-zelandiæ.

Thus rather more than half the species of *Scalpellum* recorded in Indian waters have not been found outside the Indo-Malayan region, and all are recorded from comparatively near the land, and none from mid-ocean.

The species *Euscalpellum squamuliferum* seems to be almost confined to the Bay of Bengal. There is a single published record of this species from Singapore. Along the Malay Peninsula, especially at the southern end and in the Gulf of Siam, it is largely replaced by *S. kampeni*. The latter species, however, inhabits somewhat shallower water. *S. kampeni*, in turn, is replaced almost completely by *Sc. rostratum* in the Malay Archipelago. *Sc. rostratum*, however, is a very shallow water form and is almost littoral in its distribution. Both *S. kampeni* and *Sc. rostratum* have, however, been recorded outside the Malay region, being obtained by the present expedition from the Arabian Sea. *Sc. rostratum* has also been recorded from the Philippines (Darwin, 1851). Hoek in his report on the " Siboga " Collection suggests that *Sc. rostratum* is probably one of the commonest species under the tropics, and the extension of its known area of distribution westwards to the Arabian Sea certainly tends to bear out this assertion.

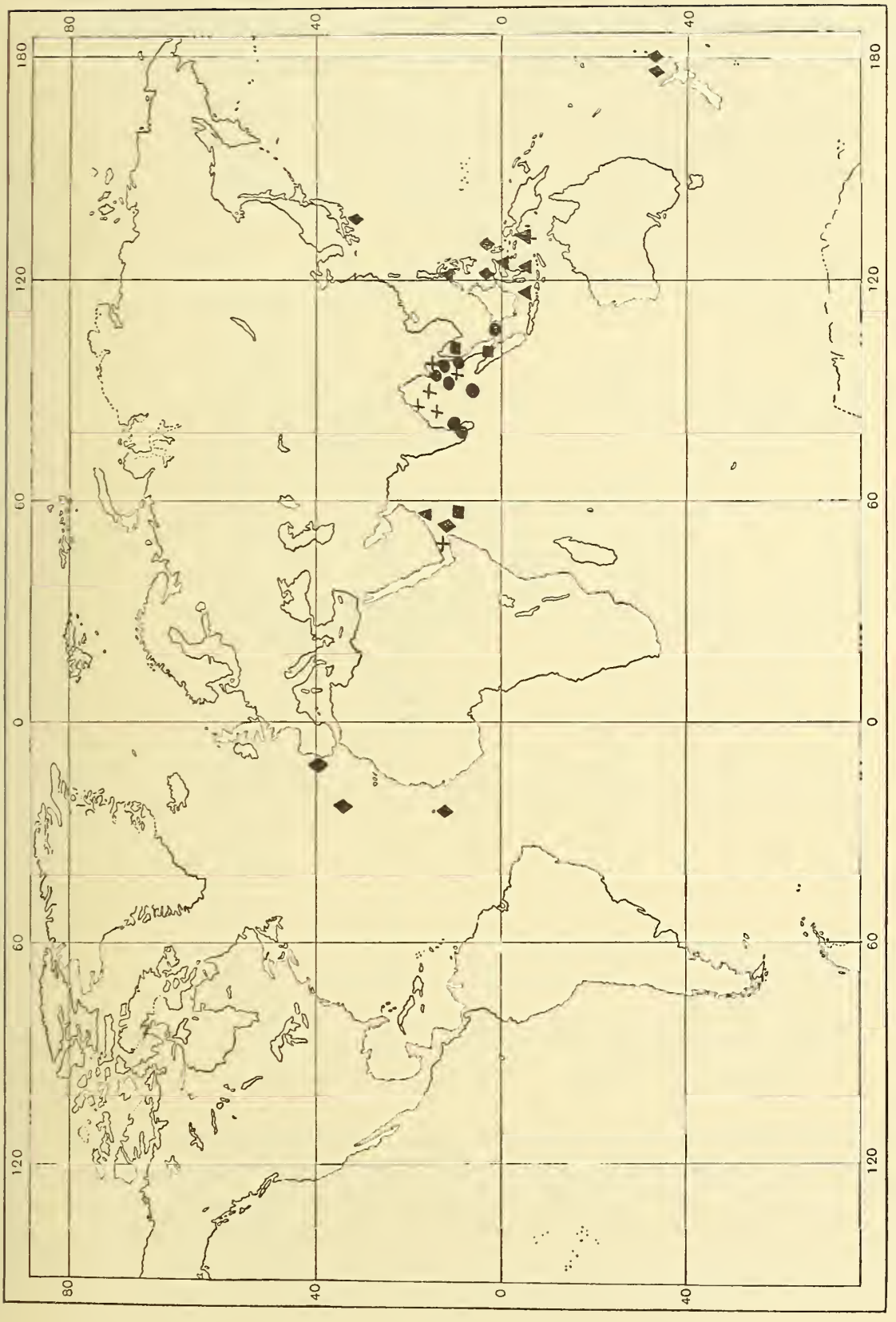
* Malay Archipelago only. † Indian Ocean only.



TEXT-FIG. 25.—Distribution of *Sc. elegans* Hoek, *Sc. diota* Hoek, *Sc. wood-masoni* Annandale and *Sc. annandalei* Calman.

Sc. (*Scalpellum*) *elegans* ● *Sc. Scalpellum*) *diota* ▲ *Sc.* (*Scalpellum*) *woodmasoni* ■
Sc. (*Scalpellum*) *annandalei* ◆

It is perhaps worthy of note that the majority of the species listed above appear to inhabit only moderately deep water, none being truly abyssal. The species of *Smilium* and *Euscalpellum* in particular seem to prefer comparatively shallow water. However, the majority of these species have been obtained only after prolonged investigation of a confined area. The low efficiency of the deep-sea trawl as a means of investigating the bottom fauna is generally recognized, as is also the patchy nature of the bottom fauna. It is obvious, therefore, that a single haul cannot give a complete qualitative estimate of the fauna of any given area. With such comparatively rare animals as many of the species of *Scalpellum* it is more the exception than the rule to obtain them in the trawl, and until really detailed work is done in a particular locality it cannot be said with any



Text-fig. 26.—Distribution of the Indian species of *Smilium* and *Euscalpellum*, *S. acutum* Hoek, *S. kampeni* Annandale, *Sc. bengalense* Annandale, *Sc. rostratum* Darwin and *Sc. squamuliferum* Annandale.

Sc. (*Smilium*) *acutum* ◆ *Sc.* (*Smilium*) *kampeni* ■ *Sc.* (*Euscalpellum*) *bengalense* + *Sc.* (*Euscalpellum*) *rostratum* ▲
Sc. (*Euscalpellum*) *squamuliferum* ●

confidence that this or that species is absent from the area. Hence there is reason to expect that at some future date some at least of these species will be shown to have a much greater range than is at present supposed.

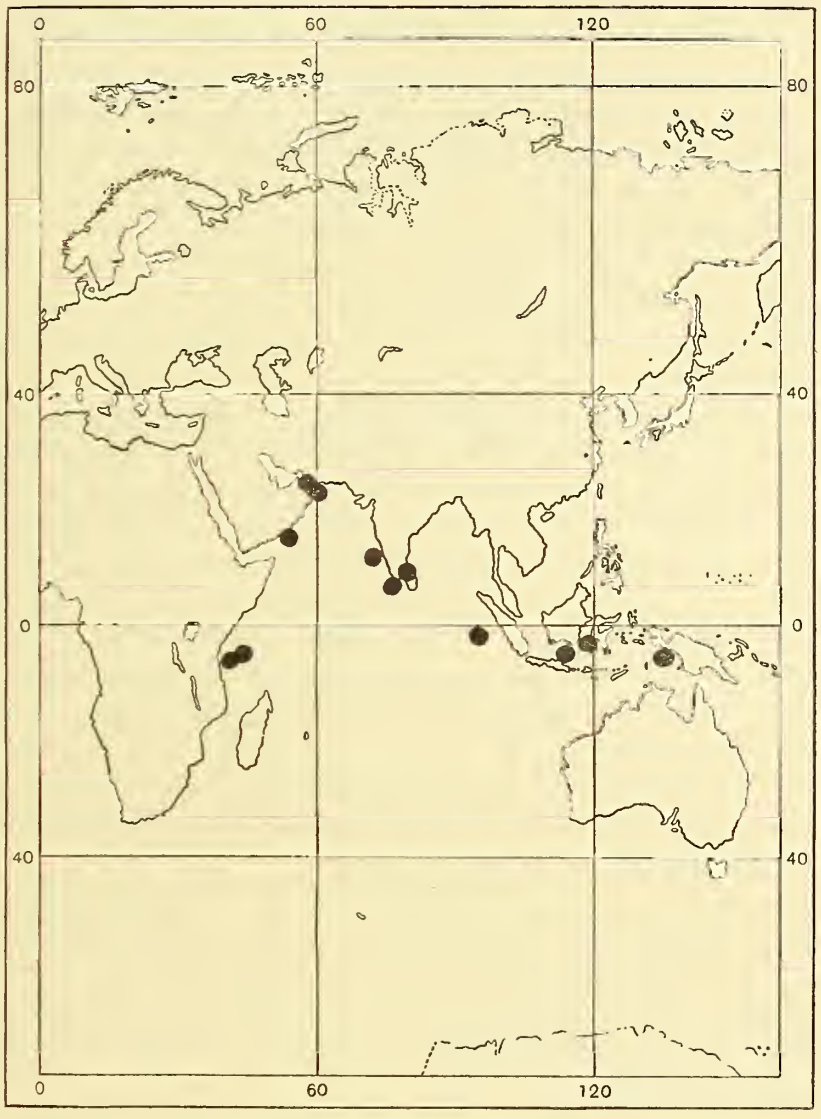
Text-fig. 27.—Distribution of the nearly related species *Sc. longius* Annandale and *Sc. lambda* Annandale.

Sc. (*Scalpellum*) *lambda* ▲ *Sc.* (*Scalpellum*) *longius* ●

A further point arising out of the distribution of the above species is the position of the two species, *Sc. lambda* and *Sc. longius*. The " Investigator " found these two species at two comparatively near stations, *Sc. lambda* in 1187 metres and *Sc. longius* in 240–462 metres. The present expedition found both species together in 762 metres. Thus the vertical distribution of these two species can be taken roughly as—

Sc. lambda, 750–1200 metres.
Sc. longius, 240–800 metres.

Annandale says regarding the validity of these species (1913, p. 235): "Possibly *Scalpellum longius* . . . is merely a complete form of *Sc. lambda*, but the structure and position of the posterior basal parts of the carinal latera of the two forms are very



Text-fig. 28.—Distribution of *Sc.* (*Scalpellum*) *laccadivicum* Annandale.

different; in *Sc. lambda* these meet over the base of the carina and have the shape of regular isosceles triangles in contact for the whole of their bases and their surface is smooth. Unless or until intermediate specimens are obtained, the two must, therefore, be regarded as specifically distinct. The greater relative height of the capitulum is quite probably an inconstant feature."

Two hypotheses are thus open to us; either (1) *Sc. longius* and *Sc. lambda* are to be regarded as the same species, the differences being due to the adjustment of the latter to increased depth and pressure, by reduction of the valves, or, alternatively (2),

they are two distinct but closely allied species, one (*Sc. longius*) living above 800 metres, below which it is replaced by *Sc. lambda*.

If the second should prove to be correct, we may expect at some future date to find *Sc. longius* in still shallower water, but not in deeper water than about 800 metres. Likewise we may expect to find *Sc. lambda* in still deeper water bordering on the abyssal zone.

It is, of course, possible that the " Investigator " specimen of *Sc. longius*, recorded from 240–462 metres, may have come from the deep end of this trawling. If we accept this assumption, the bathymetrical ranges of the two species almost coincide, 460 metres being merely an upward extension of the distribution of *Sc. lambda*, which at present stands at 750–1200 metres approximately. If this be so, there is considerable justification for combining the two so-called species as one under the name *Sc. lambda*, which has priority, although no intermediate specimens have as yet been found, and which, as Annandale points out (*vide supra*, p. 61), are necessary before a final settlement of the question can be arrived at.

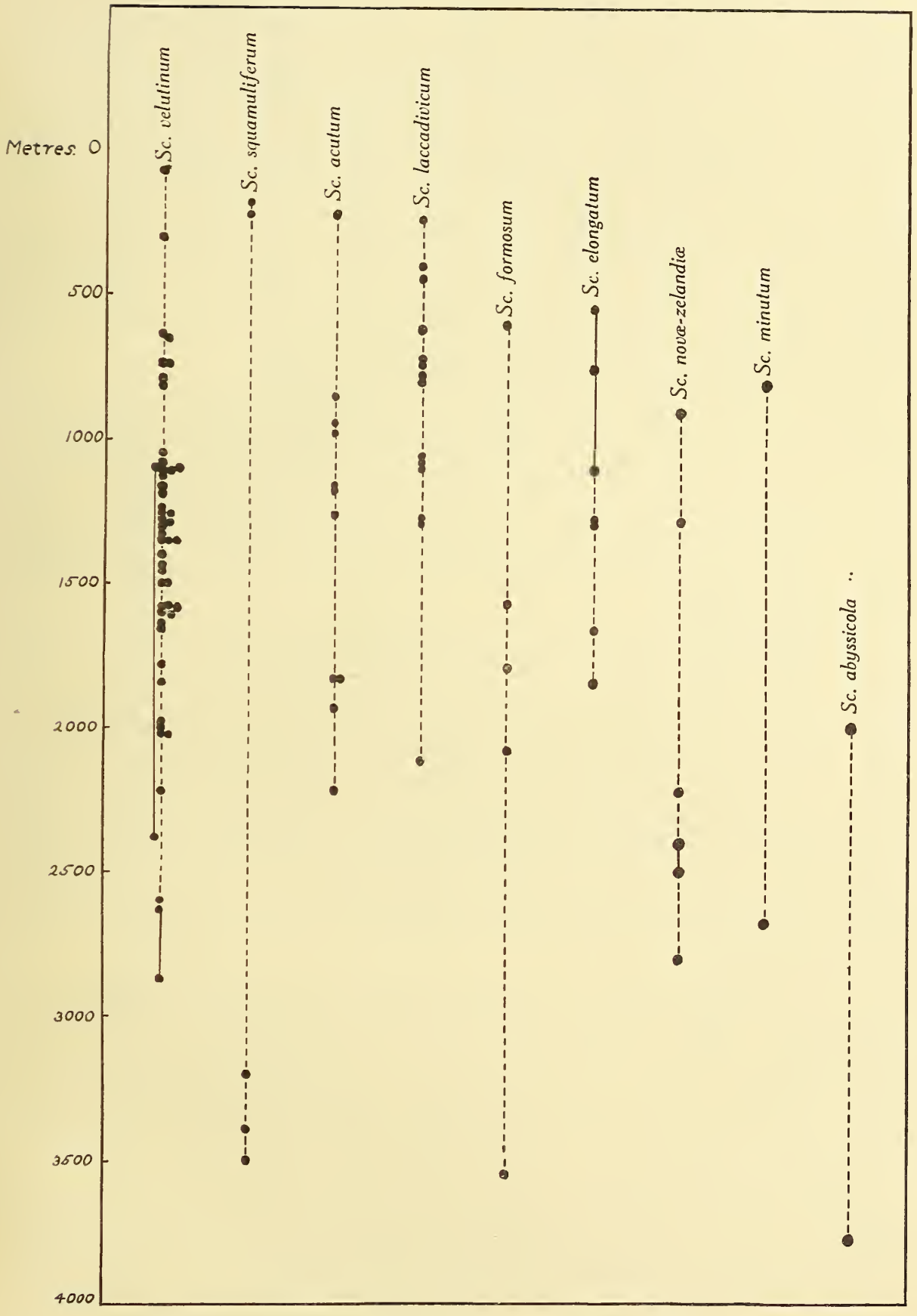
In contrast with the limited distribution of the species of *Smilium* and *Euscalpellum* (*S. kampeni*, *Sc. bengalense*, *Sc. rostratum*), collected by the expedition, and of *Sc. squamuliferum*, is that of another Indian species, *S. acutum*. In Indian waters *Smilium acutum* is known only from the Gulf of Aden. Eastwards, however, it has been found in several localities in the Malay Archipelago and the Philippine Islands and at two stations off New Zealand. The species has also been obtained in the Atlantic from the Cape Verde Islands, the Azores and the Coast of Portugal. This species of *Smilium* may thus have an almost world-wide distribution, whereas most of the species of *Smilium* and *Euscalpellum* are confined to comparatively small areas (Fig. 26). It seems that the centre of origin of this species probably lies in the East Indies, and that it has spread westwards across the Indian Ocean and southwards down the African coast, and has contrived to round the Cape of Good Hope, getting carried northwards by the cold Benguela current like *Sc. velutinum* and *Sc. minutum*.

Very little is known as to the distribution of the remaining species of *Scalpellum* from Indian Seas, but not represented in the present collection (eight in all), and it is unwise to surmise as to their possible world distribution. Mention may be made, however, of two that are apparently of wide distribution, *i. e. Sc. albatrossianum* from the Bay of Bengal and Cape Hatteras, and *Sc. pacificum* from Cape Comorin, the Gulf of Oman and the vicinity of Hawaii.

2. Bathymetrical.

Here again we are faced with the same handicaps as in discussing the geographical distribution, namely, the lack of sufficient data. For many species we have records of it having been taken at varying depths. Many of these records are separated by a vertical gap of several hundred metres. We thus get a very rough idea of the total range of a species, but as a rule we have insufficient data to more than guess at the optimum depth for a species.

The interesting case of the closely allied species *Sc. lambda* and *Sc. longius* has been discussed in the preceding section. A number of other interesting cases of species with the same geographical and/or bathymetrical distribution are known. *Sc. elongatum*,



Text-fig. 29.—Vertical distribution of species of *Scalpellum* occurring at depths greater than 2000 metres.

as far as we know from existing records, has a vertical distribution of from 550–1840 metres. *Sc. novæ-zelandiæ*, however, which has very nearly the same geographical distribution, has a rather different vertical distribution. It is unknown above 900 metres, but extends downwards half as far again as *Sc. elongatum*, having been recorded from 2800 metres west of Sumatra. Here it is possible that we are dealing with two species acclimatized to slightly different conditions of pressure and attendant factors, the one (*Sc. novæ-zelandiæ*) being adapted to almost abyssal conditions, and the other (*Sc. elongatum*) to comparatively shallow waters. If the scanty records can be stretched so far, the author would suggest that *Sc. novæ-zelandiæ* is a deep-sea species, having its habitual range below 1500 metres (say 1500–3000 metres), and that it extends upwards from that depth, overlapping the lower limits colonized by *Sc. elongatum*. The latter species seems to find a depth of 700–1500 metres most suited to its requirements, and extends upwards and to a lesser extent downwards from this zone.

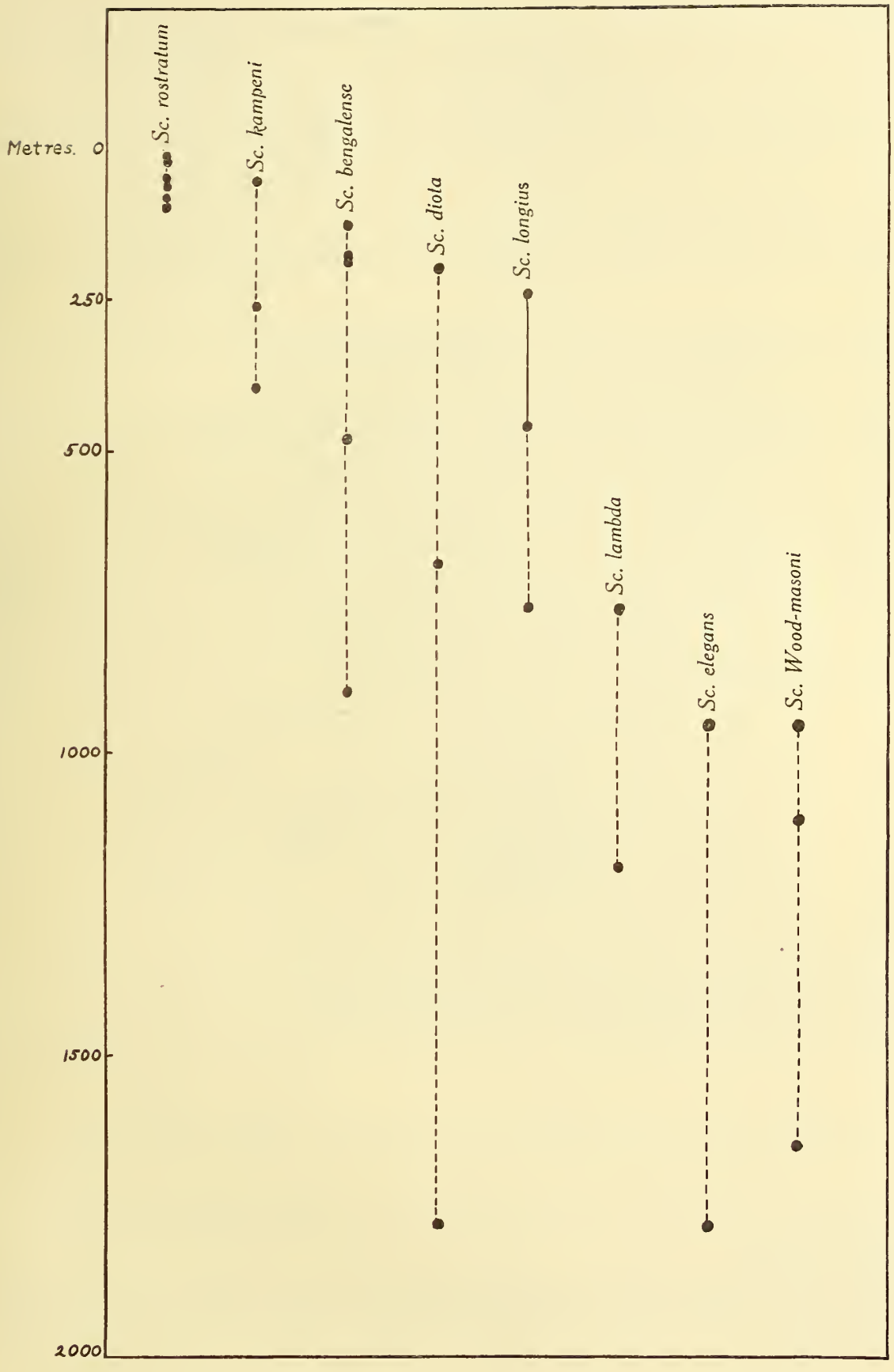
A very interesting diagram (Fig. 29) can be constructed to show the vertical distribution of *Sc. velutinum*, for which species a great number of localities are known, extending over most of the world. It has an extreme recorded range of 50–2900 metres, but, as the diagram shows, the majority of the records fall between 600 and 2000 metres, indicating fairly conclusively that this is the usual zone inhabited by this species. This very considerable range over which the species is capable of flourishing no doubt goes a long way towards accounting for the extraordinary abundance of this species in the seas of the world. *Sc. velutinum* is probably the most abundant and most widespread of all the species of *Scalpellum*.

Several species have been recorded from depths far outside what appears to be the ordinary bathymetrical range : for instance, *Sc. laccadivicum* has been taken a number of times between 250 and 1300 metres. There is, however, a solitary record of the species from over 2100 metres—800 metres deeper than any other record. Such discrepancies in depth are apt to make one hesitate before accepting the identification as correct. However, when the record comes from the pen of the founder of that species there can be little question of accepting the record as correct, and one must take it as another instance of the extraordinary adaptability of individual species of *Scalpellum*. Precisely similar instances may be quoted for *Sc. formosum*, known from 600, 1575, 1800, 2100 and 3540 metres approximately. Here the centre of distribution seems to be about 1500–2100 metres ; yet a single record is known from 900 metres above this and another more than 1400 metres below !

Of the twenty-five Indian species so far recorded, only five, *Sc. alcockianum* Annandale, *Sc. annandalei* Calman, *Sc. abyssicola* Hoek, *Sc. trapezoideum* Hoek and *Sc. albatrossianum* Pilsbry are known solely from below 1000 metres. Of these *Sc. albatrossianum* is the most remarkable, having a very small known range of only 100 metres, from 3687 to 3775 metres, although recorded from the North Atlantic and Bay of Bengal. It occurs far below all the other species, except *Sc. abyssicola*, which extends down to 3800 metres, but the latter has a much greater vertical range of 1800 metres from 2000 metres downwards.

A few other species apparently extend below the 3000 metre line, *e. g. Sc. squamuliferum*, 180–3500 metres, and *Sc. formosum*, 600–3540 metres ; but these are rather inhabitants of more moderate depths down to about 2000 metres.

No less than fourteen species do not occur above the 500 metres line, but they extend



Text-fig. 30.—Vertical distribution of species of *Scalpellum* occurring at depths less than 2000 metres.

downwards to very varying depths, having a vertical range varying from 450 metres (*Sc. lambda*) to 3000 metres (*Sc. formosum*). Eight of the remainder occur below 100 metres, and go down to depths varying from 750–3500 metres. Two of the remainder, *S. kampeni* and *Sc. rostratum*, are littoral forms occurring from a few metres downwards but not below 500 metres. The ubiquitous *Sc. velutinum* occurs in 40 metres, but is here far above its usual depth, and has only once been taken in such shallow water.

The following list shows the maximum known range of the various species recorded from Indian waters, arranged in order of depth, beginning with the shallow-water forms:

Scalpellum (*Euscalpellum*) *rostratum* Darwin, 1851, 10–100 m.
Sc. (*Smilium*) *kampeni* Annandale, 1909*b*, 25–415 m.
Sc. (*Scalpellum*) *velutinum* Hoek, 1883, 40–2900 m.
Sc. (*Euscalpellum*) *bengalense* Annandale, 1906, 125–925 m.
Sc. (*E.*) *squamuliferum* Weltner, 1894, 180–2500 m.
Sc. (*Scalpellum*) *diota* Hoek, 1907, 200–1800 m.
Sc. (*Smilium*) *acutum* Hoek, 1883, 220–2220 m.
Sc. (*Scalpellum*) *longius* Annandale, 1913, 240–760 m.
Sc. (*Sc.*) *laccadivicum* Annandale, 1906, 250–1300 m.
Sc. (*Sc.*) *sociabile* Annandale, 1905, 290–450 m.
Sc. (*Sc.*) *pacificum* Pilsbry, 1907*a*, 400–2400 m.
Sc. (*Sc.*) *elongatum* Hoek, 1883, 550–1850 m.
Sc. (*Sc.*) *formosum* Hoek, 1907, 600–3550 m.
Sc. (*Sc.*) *lambda* Annandale, 1910*a*, 760–1200 m.
Sc. (*Sc.*) *gruvelii* Annandale, 1906, 790–2220 m.
Sc. (*Sc.*) *curimosum* Hoek, 1907, 790–? m.
Sc. (*Sc.*) *minutum* Hoek, 1883, 800–2700 m.
Sc. (*Sc.*) *novæ-zelandiæ* Hoek, 1883, 900–2800 m.
Sc. (*Sc.*) *wood-masoni* Annandale, 1906, 950–1650 m.
Sc. (*Sc.*) *elegans* Hoek, 1907, 950–1900 m.
Sc. (*Sc.*) *trapezoideum* Hoek, 1907, 1090–1570 m.
Sc. (*Sc.*) *alcockianum* Annandale, 1906, 1290–1800 m.
Sc. (*Sc.*) *annandalei* Calman, 1918, 1290–2220 m.
Sc. (*Sc.*) *abyssicola* Hoek, 1883, 2000–3800 m.
Sc. (*Sc.*) *albatrossianum* Pilsbry, 1907*b*, 3687–3775 m.

Remarks on the Distribution of the Cirripedia in the Arabian Sea.

Of the several localities in which Cirripedia were collected by the expedition, two, the Zanzibar Area and the Gulf of Aden, stand out as being especially favourable areas for these animals.

The Zanzibar Area has proved especially rich. The individuals from this region represent twenty species of the forty-three collected by the expedition. The following were found there:

Pœcilasma kæmpferi.
P. crassa.
P. excavatum.
Dichelaspis tridens.
Megalasma minus.
Heteralepas typica.
Scalpellum diota.
Sc. formosum.
Sc. laccadivicum.
Sc. lambda.
Sc. longius.
Sc. minutum.
Sc. velutinum.
Verruca murrayi.
V. sewelli.
V. capsula.
V. macani.
Balanus amphitrite communis.
B. albus.
B. echinoplacis.

In addition to these *Megalasma* (*Glyptelasma*) *hamatum* has been previously recorded from this area.

In all there were twenty-four stations in this area, at fifteen of which a net of some kind was used; seven were Petersen Grab stations, and two hydrographical. Hence there were only fifteen stations at which relatively rare animals like Barnacles could be hoped for in the catch, and that of these, eleven should yield one or more species is sure evidence of the abundance of these animals in this area compared with the rest of the Ocean. Sta. 106 proved exceptionally prolific, yielding five species—*Pœcilasma kæmpferi*, *crassa* and *excavatum*, *Dichelaspis tridens* and *Balanus echinoplacis*. Stations 122 with four and 109 and 115 with three each come next. Stations 105, 108, 110 and 118 each yielded two, and Stations 107, 111 and 120, one each.

The Gulf of Aden, while not so prolific of species as the Zanzibar Area, yielded the following thirteen species:

Lepas anserifera.
L. anatifera.
Pœcilasma excavatum.
Dichelaspis nierstraszi.
Oxynaspis aurivillii.
Smilium kampeni.
Scalpellum abyssicola.
Balanus amaryllis.
B. albus.
B. ciliatus.
B. thompsoni.
B. cymbiformis.
B. navicula.

While the frequency of Cirripedia is apparently still above the average in this area, they are by no means as abundant as in the Zanzibar Area, and only two species are common to both areas. Of eighteen trawling and dredging stations carried out in this region, seven yielded Barnacles. At some stations the species seem fairly abundant. Thus Sta. 24 yielded—

Smilium kampeni, *B. thompsoni*,
Balanus ciliatus, *B. navicula*,

and Sta. 27,

Pœcilasma nierstraszi, *Balanus cymbiformis.*
Oxynaspis aurivillii,

Sta. 194, which yielded a very large catch of animals, especially of *Puerulus angulatus* Spence Bate, yielded two Cirripedes, *Pœcilasma excavatum* (on the *Puerulus*) and *Balanus albus*. Sta. 35 likewise yielded two species, *Balanus amaryllis* and *B. cymbiformis*. The other three stations, 25, 39 and 185, each yielded one only.

It is interesting to note that the number of species of *Scalpellum* has fallen from seven in the Zanzibar Area to two in the Gulf of Aden, while the number of *Balanus* species has increased from three to six.

Going still further north along the South Arabian Coast the number of species obtained falls still lower. Out of seventeen trawling and dredging stations (two of them shallow-water motor-boat dredgings), only six yielded Cirripedes belonging to six species and one variety. Two others from this area belong to the littoral fauna of the Kuria Muria Islands. The greatest number of species was obtained at Sta. 54, which yielded two species, *Sc. elegans* and *Sc. wood-masoni*, and a new variety of the latter, *Sc. wood-masoni* var. *murrayi* nov. Here the frequency of the Cirripedes is much the same as in the other parts of the oceans—the animals are few in species and numbers. It is in this area, moreover, that large tracts occur practically devoid of animal life owing to the presence of sulphuretted hydrogen gas in the mud.

LIST OF REFERENCES.

Annandale, N. 1905. Malaysian Barnacles in the Indian Museum. Mem. Asiat. Soc. Bengal, I, pp. 73-84, pl. viii, figs. 1–3.

—— 1906. Preliminary Report on the Indian Stalked Barnacles. Ann. Mag. Nat. Hist. (7) XVII, pp. 389–400.

—— 1907–1908. Illustrations of the Zoology of the " Investigator ". Crust. Entom. pls. i–v.

—— 1909*a*. An Account of the Indian Cirripedia Pedunculata : Pt. I, Fam. Lepadidæ s. str. Mem. Indian Mus. II, pp. 61–138, pls. vi–vii, text-figs. 1–11.

—— 1909*b*. Description of a Barnacle of the Genus *Scalpellum* from Malaysia. Rec. Indian Mus. III, pp. 267–270, text-figs. 1–4.

—— 1909*c*. The Rate of Growth in *Conchoderma* and *Lepas*. Rec. Indian Mus. III, p. 295.

—— 1910*a*. Description of a New Species of *Scalpellum* from the Andaman Sea. Rec. Indian Mus. V, pp. 115–116.

—— 1910*b*. Two Barnacles of the Genus *Dichelaspis* New to Indian Seas. Rec. Indian Mus. V, pp. 213–214.

—— 1910*c*. Report on the Cirripedia Pedunculata Collected by Dr. Mortensen in the Gulf of Siam. Vidensk. Medd. naturh. foren. Kjøbenhavn, pp. 81–86.

—— 1910*d*. The Indian Barnacles of the Subgenus *Smilium* with Remarks on the Classification of the Genus *Scalpellum*. Rec. Indian Mus. V, pp. 145–155, text-figs. 1, 2.

—— 1911. Some Barnacles of the Genus *Scalpellum* from Irish Seas. Ann. Mag. Nat. Hist. (8) VII, pp. 588–590, 1 text-fig.

—— 1913. The Indian Barnacles of the Subgenus *Scalpellum*. Rec. Indian Mus. IX, pp. 227–236.

—— 1914. New and Interesting Pedunculate Cirripedes from Indian Seas. Rec. Indian Mus. X, pp. 273–280, pls. xxxiii, xxxiv.

—— 1916. Three Plates to Illustrate the Scalpellidæ . . . of Indian Seas, etc. Mem. Indian Mus. VI, pp. 127–131, pls. vi–viii.

Aurivillius, C. W. S. 1894. Studien über Cirripeden. K. Svenska Vetensk. Akad. Handl. XXVI, no. 7, pp. 5–89, pls. i–ix.

Barnard, K. H. 1924. Contributions to the Crustacean Fauna of South Africa : 7. Cirripedia. Ann. S. Afr. Mus. Capetown, XX, pp. 1–103, pl. i.

—— 1925. Report on a Collection of Crustacea from Portuguese East Africa. Trans. Roy. Soc. S. Africa, XIII, pp. 119–129, pls. x, xi.

Borradaile, L. A. 1903. Marine Crustaceans : VII. The Barnacles (Cirripedia). In Fauna and Geog. of the Maldive and Laccadive Archipelagoes, I, ed. J. S. Gardiner, pp. 440–443, text-figs. 118, 119.

Broch, Hj. 1922. Papers from Dr. Mortensen's Pacific Expedition 1914–16 : X. Studies on Pacific Cirripeds. Vidensk. Medd. naturh. foren. Kjøbenhavn, LXXIII, pp. 215–358, text-figs. 1–77.

—— 1931. Papers from Dr. Mortensen's Pacific Expedition 1914–16 : LVI. Indo-Malayan Cirripedia. Vidensk. Medd. naturh. foren. Kjøbenhavn, XCI, pp. 1–146, text-figs. 1–41.

Calman, W. T. 1918. On Barnacles of the Genus *Scalpellum* from Deep-sea Telegraph Cables. Ann. Mag. Nat. Hist. (9) I, pp. 96–124, text-figs. 1–7.

—— 1919. On Barnacles of the Genus *Megalasma* from Deep-sea Telegraph Cables. Ann. Mag. Nat. Hist. (9) IV, pp. 361–374, text-figs. 1–7.

Darwin, C. 1851. Monograph on the Sub-class Cirripedia : I. Lepadidæ. Ray Society, London, pp. xi, 400, 11 pls.

—— 1854. Monograph on the Sub-class Cirripedia : II. The Balanidæ ; the Verrucidæ. Ray Society, London, pp. viii, 684, 31 pls.

Fischer, P. 1885. Cirrhipèdes de l'Archipel de la Nouvelle Calédonie. Bull. Soc. Zool. de France, IX (1884), pp. 355–360.

Gray, J. E. 1825. A Synopsis of the Genera of Cirripedes arranged in Natural Families, with a Description of some new Species. Ann. Philosophy London, new series X, pp. 97–107.

Gruvel, A. 1902. Cirrhipèdes. Exped. scient. du " Travailleur " et du " Talisman " pendant 1880–83, pp. 1–179, pls. i–vii.

—— 1905. Monographie des Cirrhipèdes. Paris, pp. xii, 472, text-figs.

—— 1907. Cirrhipèdes Operculés de l'Indien Museum de Calcutta. Mem. Asiat. Soc. Bengal, II, pp. 1–10, pls. i, ii.

Hinds, R. B. 1844. The Zoology of the Voyage of H.M.S. " Sulphur ". Vol. II, Mollusca, pp. 1–72, pls. i–xxi. (Cirripedes, pp. 71, 72, pl. xxi, fig. 5.)

Hiro, F. 1931. Notes on some Cirripedia from Japan. Mem. Coll. Sci. Kyoto, Japan, VII B, pp. 143–158, pls. xi–xiv, text-figs. 1–11.

Hoek, P. P. C. 1883. Report on the Cirripedia Collected by H.M.S. " Challenger ", 1873–76. Rep. Sci. Results " Challenger " Exped. Zool. VIII, pp. 169, 13 pls.

—— 1907. The Cirripedia Pedunculata. Siboga-Exped. Monog. XXXI*a*, pp. i–xxv and 1–128, pls. i–x.

—— 1913. The Cirripedia Sessilia. Siboga-Exped. Monog. XXXI*b*, pp. 129–275, pls. xi–xxvi.

Jennings, L. S. 1914. Pedunculate Cirripedia of New Zealand and Neighbouring Islands. Trans. and Proc. N.Z. Inst. XLVII, pp. 285–293, text-figs. 1–1*c*, Wellington, 1915.

Krüger, P. 1911. Beiträge zur Cirripedienfauna Ostasiens. Abh. Bayer. Akad. Wiss. II, Suppl. Bd., Abh. 6, pp. 1–72, pls. i–iv, text-figs. 1–131.

Lanchester, W. F. 1902. On the Crustacea Collected during the " Skeat " Exped. to the Malay Peninsula. Proc. Zool. Soc. London, 1902 (2), pp. 363–381, pls. xxxiv, xxxv.

Linnæus, C. 1788. Systema Naturæ. 13th Ed., tom. I, pars. VI, pp. 3207–3214.

Meisenheimer, J. 1905. Pteropoda. In Wiss. Ergebn. Deutschen Tiefsee Exped. 1898-99, Bd. IX, pp. 1–314, pls. i–xxvii, text-figs. 1–35, 9 charts.

Nilsson-Cantell, C. A. 1921. Cirripeden-studien. Zool. Bidrag Uppsala, VII, pp. 75–395, pls. i–iii, text-figs. 1–89.

—— 1927. Some Barnacles in the British Museum (Nat. Hist.). Proc. Zool. Soc. London, 1927, pt. 2, pp. 743–790, pl. i, text-figs. 1–19.

—— 1928. Studies on Cirripeds in the British Museum (Nat. Hist.). Ann. Mag. Nat. Hist. (10) II, pp. 1–39, text-figs. 1–16.

—— 1932. Cirripeds from the Indian Ocean and Malay Archipelago in the British Museum (Nat. Hist.), London. Ark. Zool. Stockholm, XXIII A, no. 18, pp. 1–12, text-figs. 1–3.

—— 1934. Indo-Malayan Cirripeds in the Raffles Museum. Bull. Raffles Mus. Singapore, no. 9, pp. 42–73, pl. v, text-figs. 1–7.

Pilsbry, H. A. 1907*a*. Hawaiian Cirripedia. Bull. Bur. Fish. Washington, XXVI, 1906, pp. 179–190, pls. iv, v.

—— 1907*b*. The Barnacles (Cirripedia) Contained in the Collections of the American Museum of Nat. Hist. Bull. U.S. Nat. Mus. LX, pp. x, 1–122, pls. i–xi, text-figs. 1–36.

—— 1907*c*. Notes on the Cirripede Genus *Megalasma*. Proc. Acad. Nat. Sci. Philadelphia, LIX, pp. 408–416, pl. xxxi, text-figs. 1–7.

—— 1908. On the Classification of the Scalpelliform Barnacles. Proc. Acad. Nat. Sci. Philadelphia, LX, pp. 104–111, text-fig. 1.

—— 1912. Diagnoses of New Barnacles from the Philippine Archipelago and China Sea. Proc. U.S. Nat. Mus. XLII, pp. 291–294.

—— 1916. The Sessile Barnacles (Cirripedia) Contained in the Collections of the U.S. National Museum, including a Monograph of the American Species. Bull. U.S. Nat. Mus. XCIII, pp. i–xi, 1–366, pls. i–lxxvi.

Schott, G. 1926. Geographie des Atlantischen Ozeans. Hamburg. Pp. xiv, 368, 1 pl., 30 maps, text-figs.

—— 1935. Geographie des Indischen und Stillen Ozeans. Hamburg. Pp. xix, 413, 1 pl., 37 maps, text-figs.

Sewell, R. B. S. 1926. A Study of *Lithotrya nicobarica* Reinhardt. Rec. Indian Mus. XXVIII, pp. 269–330, pls. xiv, xv, text-figs. 1–18.

Stebbing, T. R. R. 1900. On Crustacea brought by Dr. Willey from the South Seas. Willey's Zool. Results, pt. V, pp. 605–690, pls. lxiv–lxxiv.

—— 1910. General Catalogue of South African Crustacea. Ann. S. Afr. Mus. Capetown, VI, pp. 281–593, pls. xv–xxii.

Stewart, F. H. 1911. Studies in Postlarval Development and Minute Anatomy in the Genera *Scalpellum* and *Ibla*. Mem. Indian Mus. III, pp. 33–51, pls. iv–vii.

Totton, A. K. 1923. Antipatharia (and their Cirripede Commensals). Brit. Mus. (Nat. Hist.) Brit. Antarctic ("Terra Nova") Exped. 1910, Nat. Hist. Reports, Zool. V, no. 3, pp. 97–119, pls. i, ii.

Weltner, W. 1894. Zwei neue Cirripedien aus dem indischen-Ocean. S.-B. Ges. Naturf. Fr. Berlin, pp. 80–87.

—— 1897. Die Cirripedien Helgolands. Wiss. Meeresuntersuch. Neue Folge. Bd. II, Kiel und Leipzig, pp. 436–447.

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SCIENTIFIC REPORTS

VOLUME IV. No. 2

ON A NEW SPECIES OF *HALOBATES*, A GENUS OF PELAGIC HEMIPTERA

BY

A. D. IMMS, F.R.S.,

Zoological Laboratory, Cambridge.

WITH SEVEN TEXT-FIGURES

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ON A NEW SPECIES OF *HALOBATES*, A GENUS OF PELAGIC HEMIPTERA

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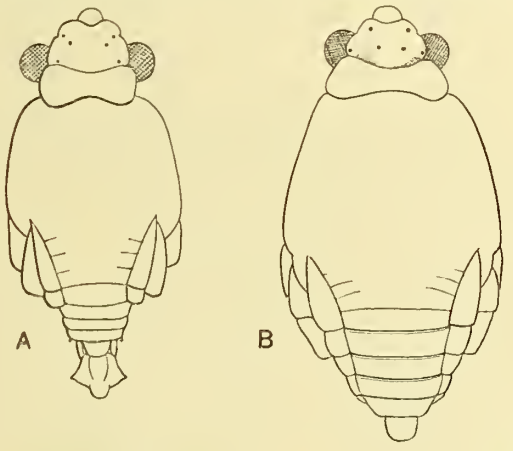
WITH SEVEN TEXT-FIGURES.

The present paper is based upon material collected by the John Murray Expedition and upon specimens contained in the collections of the British Museum (Natural History), The insects concerned are all referable to a species hitherto unknown, and it is here described as *Halobates sewelli* sp. nov., after Lt.-Col. Sewell, leader of the Expedition.

Occurrence.

(*a*) *John Murray Expedition.*—Station 61. Entrance to the Gulf of Oman, about half-way between the coasts of India and Arabia. Three females, one male and four nymphs. Taken in tow-net at night, November 8th–9th, 1933. Ten females, three males and nine nymphs taken in surface tow-net at night, November 8th, 1933.



Text-fig. 1.—*Halobates sewelli* sp. nov. A, male. × 12·5. B, female. × 12·5.

(*b*) *British Museum* (*Natural History*).—Red Sea, Genaba, near Farsan Is., February 26th, 1926. Twelve females, one male and six nymphs. Caught at 10 p.m. with light over stern. Sea temperature 80° F. Presented by W. Macfadyn (B.M., 1927–157).

Description of Male.

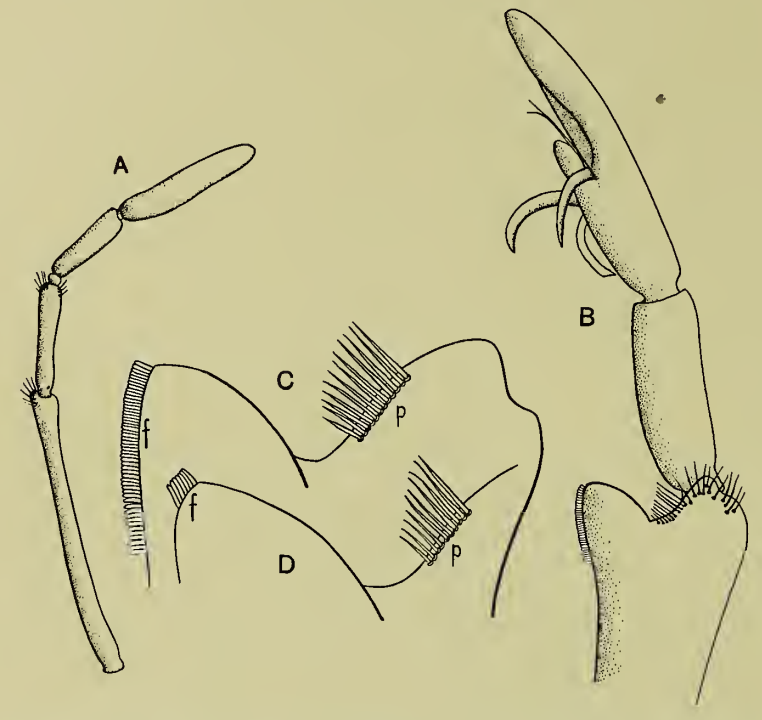
Coloration.—Uniformly blue-black above and below with ashy grey minute pubescence ; fore femora similar. Eyes, antennæ, middle and hind legs, exposed parts of 8th abdominal segment, including styliform appendages, and ventral aspect of lateral lobes of 9th

abdominal segment, brown-black or black. Paired, wedge-shaped, rufous maculæ at base of head not, or only slightly, evident.

In alcohol, colour is steely blue, with the eyes chocolate brown and remaining parts brown-black.

Size.—Length 3·8 to 4 mm. Maximum breadth 1·75 mm. (Text-fig. 1A).

Antennæ.—Length 2·5 mm. The segments (Text-fig. 2) related in length as 11 : 4 : 3 : 5 (excluding the two small subsegments).



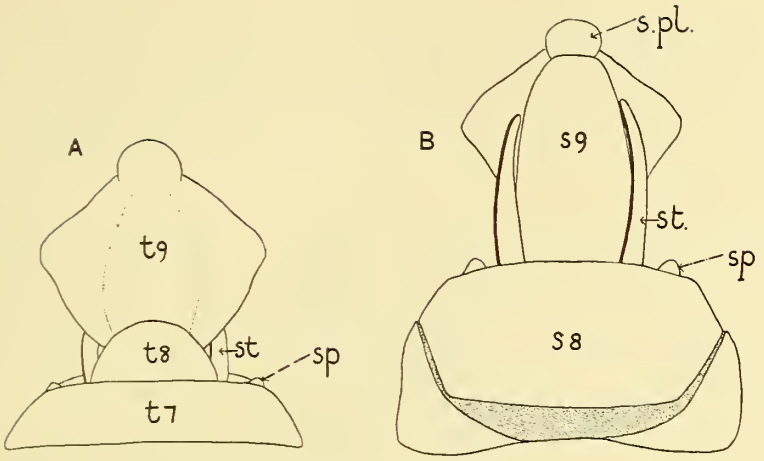
TEXT-FIG. 2.—*H. sewelli.* A, left antenna of male. × 50. B, apex of left tibia and tarsus of fore-leg of male. × 100. C, apex of left tibia of fore-leg of male. D, ditto of female, showing pecten *p* and "file" *f*. × 220.

Thorax.—Pronotum with sides somewhat rounded; anterior and posterior margins definitely concave. Mesonotum with shoulders well defined and rounded.

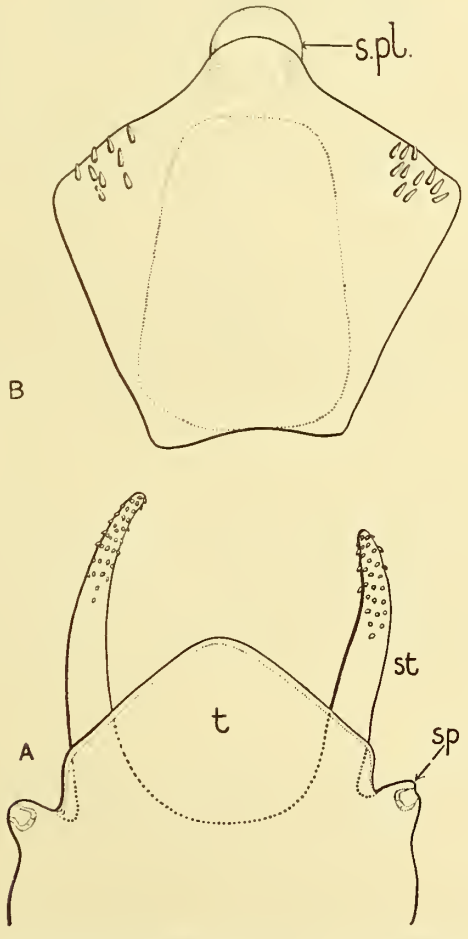
Fore leg.—Femur related in length to tibia as 25 : 19, or approximately as 4 : 3. Tarsal segments (Text-fig. 2) related in length as 8 : 13. Second tarsal segment with usual curved paired claws, together with a reflected translucent ribbon-like process whose apex is obliquely truncated; also arising from tarsal fossa is a very slender bifid seta. Tibia with a pecten of about 12 spines and a ventral file of about 50 closely set, blunt, peg-like spines (Text-figs. 2B and C).

Middle leg.—Femur 4·4 to 4·5 mm. long—·5 mm. shorter than tibia + tarsus. Femur related in length to tibia as 3 : 2. Tibia related in length to tarsus as 17 : 11, approximately as 3 : 2. Tarsal segments similarly related as 11 : 3. Two macrochætæ and an obscure ribbon-like appendage arising from fossa of 2nd tarsal segment, the latter ending in a sharp point with two subapical macrochætæ.

Hind leg.—Femur 3·75 to 4 mm. long; related in length to tibia + tarsus as 8 : 5. Tibia related to tarsus as 7 : 2. Tarsus armed with a long subapical macrochæta and, arising from the fossa, are two flattened claws and a macrochæta.



TEXT-FIG. 3.—*H. sewelli*. Apex of abdomen of male. A, dorsal aspect. B, ventral ditto. S_8, 8th abdominal sternum. S_9, 9th abdominal sternum. *sp.*, spiracular process. *s.pl.*, subanal plate. *st.*, styliform appendage (left in A, right in B). t_7 to t_9, 7th to 9th abdominal terga. × 60.



TEXT-FIG. 4.—*H. sewelli*. A, 8th abdominal segment of male (dorsal aspect). B, 9th tergum of male (dorsal aspect). *sp.*, spiracular process. *s. pl.*, subanal plate. *st.*, styliform appendage (left). *t.*, tergum. × 100.

Abdomen.—Dorsally, first three segments only defined laterally, subequal in size; 4th segment the longest, its anterior margin arched; 5th to 7th segments equal in size; visible parts of 8th segment consisting of a rounded median lobe and the apices of the paired spiracular processes; 9th segment about as broad as long, elevated down the middle, lateral lobes deflected somewhat, with a group of 10 or 11 denticles on each side (Text-figs. 1A, 3A and 4).

Ventrally, first five segments ring-like, subequal in length; 6th segment with sclerotized lateral lobes strongly developed and embracing sides of 7th segment; 7th segment nearly as long as segments 1–7 together; 8th segment with styliform processes incurved at apices, right slightly longer than left, and each armed with denticles over the distal one-third; 9th sternum convex, elongate-oval; sub-anal plate slightly transverse-ovoid (Text-figs. 3B and 4A).

Genitalia.—Pygophore (capsule of some authors) ovoid and globular. Aedeagus with a longitudinal fissure in the basal one-third; apex filiform. Parameres, left broader and shorter than right, curved distally; right narrower and more rod-like (Text-fig. 7B).

Description of Female.

Coloration.—Uniformly blue-black above and below, with ashy grey minute pubescence. Legs, antennæ and apex of abdomen brown-black or black; eyes rather paler. Intersegmental membranes between abdominal terga 3 to 5 in some specimens appear pale brown. Abdominal sterna 1 to 6 dark brown, with membranous areas pale brown. Wedge-shaped paired, rufous maculæ at base of head present, but often obscure.

Size.—Length 4·5 mm. Maximum breadth 2 to 2·5 mm. Broader and more ovoid than the male (Text-fig. 1B).

Antennæ.—Length 2·25 to 2·5 mm. First segment related in length to remaining segments together in proportion of 13 : 18 (in males as 11 : 12).

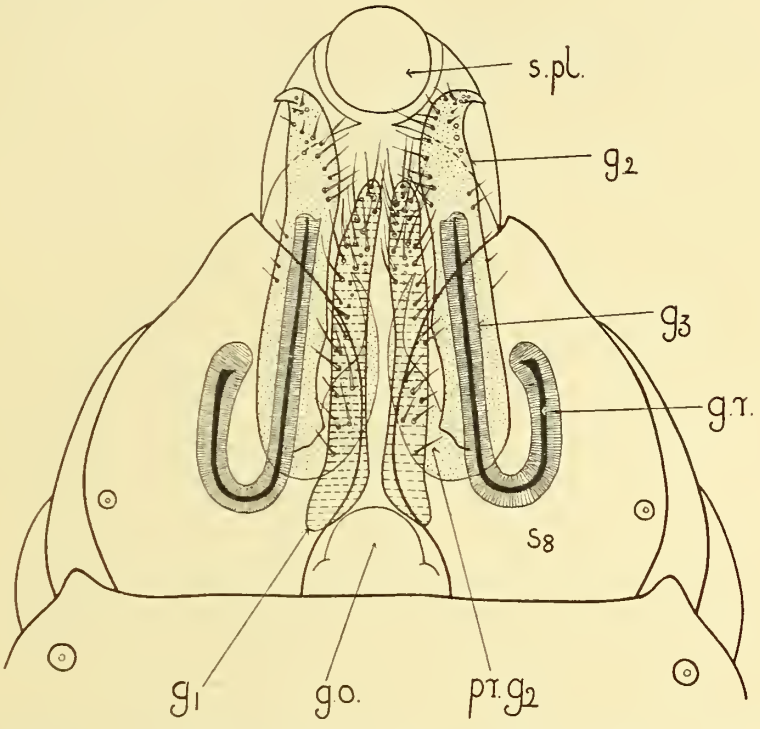
Fore leg.—Pecten at apex of tibia composed of about 10 spines; the "file" represented by about 7 closely set, blunt, peg-like spines (Text-fig. 2D).

Middle and hind legs.—These do not differ significantly from the corresponding parts in the male.

Abdomen.—Dorsally (Text-fig. 1B), segments 1 to 4 equal in length, a little shorter than any of segments 4 to 8, which are subequal in length. Segment 9 with rounded papilliform terminal lobe alone visible without dissection. Ventrally, first 6 segments narrow and annular, 6th segment produced and widened laterally; 7th segment longest and 8th segment in the form of paired valves; 9th segment with a backwardly-directed median lobe alone visible without dissection, a rounded subanal plate hinged to latter ventrally (Text-fig. 5).

Ovipositor.—Using the terminology employed by Carpenter (1906), the anterior valves are elongate and finger-like, beset throughout their length with macrochætæ. Inner posterior valves the longest, flattened, and each ending in a small, sharp, outwardly directed tooth; each valve is beset with small spines apically, and a row of long macrochætæ along distal one-third of inner margin; basally each valve gives off an inner, sharply-pointed, acuminate process. Along the outer margin of each valve is a sclerotized ridge, or "guide rail", which is prolonged basally into the body as a recurved ramus. Outer posterior valves articulating by means of grooves with the aforementioned ridges

(or guide rails) on inner valves ; each outer valve prolonged basally into a recurved ramus (Text-fig. 5). The above description applies to the ovipositor in the retracted condition ; when extended, the rami of the two pairs of posterior valves become straightened, thus allowing of the extension of the parts involved.



TEXT-FIG. 5.—*H. sewelli*. Ovipositor, ventral aspect. g_1, anterior valve. g_2, inner posterior valve. g_3, outer posterior valve. *g.o.*, genital operculum. *g.r.*, " guide rail " of inner posterior valve. *pr.* g_2, inner process of valve g_2. S_8, right plate of 8th sternum. *s.pl.*, subanal plate. × 84. (*Note.*—Anterior valves are shaded with cross-lines and inner posterior valves have dot shading.)

Comparisons with Allied Species.

H. sewelli appears to be more closely allied, structurally, to *H. hayanus* White than to any other species of the genus. This fact has led me to investigate the genitalia and the 8th and 9th abdominal segments of Buchanan White's type of *H. hayanus* in the collection of the British Museum (Natural History). The chief differences are shown in Figs. 4 and 6, and are also expressed in tabular form below :

H. sewelli sp. nov.	*H. hayanus* White.
The 8th abdominal tergum narrowed considerably towards apex of median posterior lobe.	Median posterior lobe of 8th tergum distinctly broader apically.
Right styliform process somewhat longer than left and both processes incurved distally.	Styliform processes of equal length and slightly curved outwards distally.
Denticles over distal one-third of each styliform process.	Denticles over distal one-fourth of each styliform process.

H. sewelli sp. nov.—*cont.*

Lateral angles of 9th tergum produced just beyond proximal half of that sclerite.

Lateral denticles 10 or 11 on either side.

Parameres small, slightly narrowed towards apices (Text-fig. 7B).

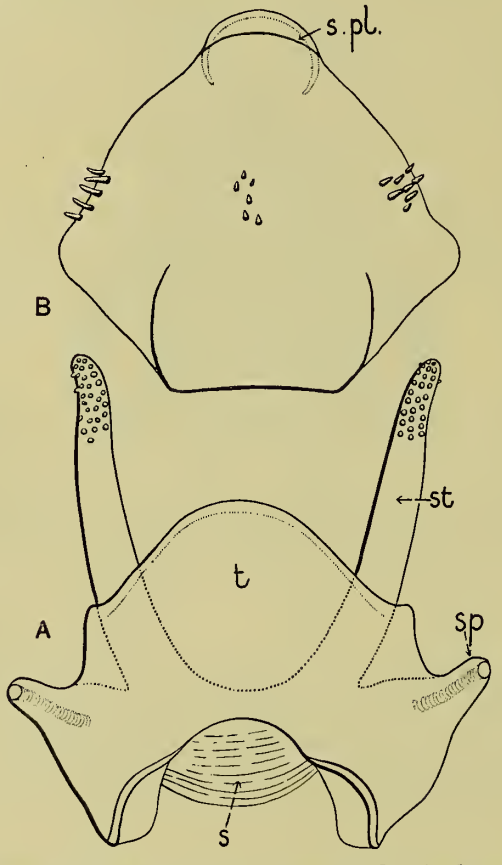
H. hayanus White.—*cont.*

Lateral angles of 9th tergum produced within the proximal half of that sclerite.

Lateral denticles less numerous.

Parameres very distinctly larger with distal extremities broader (Text-fig. 7A).

The ædeagus shows no significant differences in the two species.



TEXT-FIG. 6.—*Halobates hayanus* White (type). A, 8th abdominal segment of male (dorsal aspect). B, 9th abdominal tergum of male (dorsal aspect). *s.*, sternum. Other lettering as in Text-fig. 4. × 100.

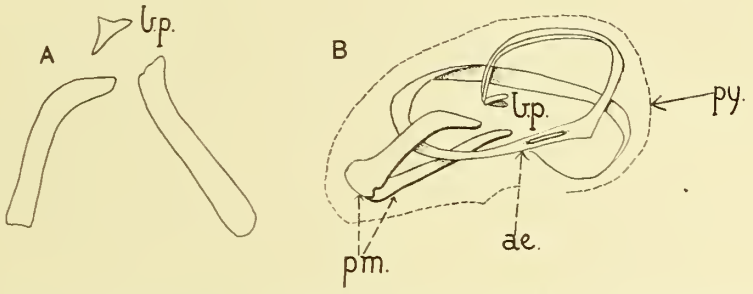
In coloration both sexes of the two species can be separated at a glance. The conspicuous yellowish ochreous bases to the antennæ, and the extensive suffusion of the same colour ventrally in *H. hayanus*, readily separates that species from the unicolorous, blue-black, *H. sewelli*. In the male of *H. hayanus*, the 9th tergal shield is more or less yellow ochreous, whereas in *sewelli* it is blue-black or black.

According to Buchanan White, *H. hayanus* is closely related to *H. proavus* White. Esaki (1930), who has examined the male type specimen of *H. proavus* in the collection of the British Museum (Natural History), states that this species is identical with *H. rotundatus* Esaki from New Guinea (*vide* Esaki, 1926). He remarks that Buchanan White's figures and description are very inaccurate. The very short first segment of the fore tarsi, of both sexes, and the pronounced asymmetry of the styliform processes of the 8th abdominal segment, as figured by Esaki, serve to separate *H. proavus* from both *H. hayanus* and *H. sewelli*.

H. sewelli closely resembles *H. sericeus* Esch. in coloration, but, from Buchanan White's description (1883), there are evident structural differences in the males as shown in tabular form below :

H. sewelli sp. nov.	*H. sericeus* Esch.
Middle tibia definitely longer than tarsus ; tarsal segments related in length as 11 : 3. Apical half of disc of 8th segment devoid of teeth.	Middle tibia a little shorter than tarsus ; tarsal segments related in length as 7 : 1. Apical half of disc of 8th segment with short, outwardly pointing teeth.

H. flaviventris Esch. (*herdmani* Carp.) may be easily separated from *H. sewelli* by the tarsal segments of the fore leg being subequal in length, whereas in *sewelli* they are related as 8 : 13. The females may also be separated upon structural differences in the ovipositor, as mentioned on p. 78.



Text-fig. 7.—A, parameres of *Halobates hayanus* White (type) with basal plate, *b.p.* × 104. (Distal extremities of parameres are nearest the basal plate.) B, male genitalia of *H. sewelli* sp. nov. *æ.*, ædeagus. *b.p.*, basal plate. *p.m.*, parameres. *py.*, pygophore. × 104.

The well-known fact that the genus *Halobates* occurs throughout the warmer seas suggests that temperature is a limiting factor in its distribution. Since these insects are wingless, surface-living forms, their extremely wide geographical range is also most probably strongly influenced by ocean currents—a factor which has not so far attracted much attention. From data available, for example, in the recent text-book by Schott (1935), it will be seen that the occurrence of *H. sewelli*, in both the Red Sea and near the Gulf of Oman, is on the direct courses of the prevailing marine currents. During February and March the flow is from the Gulf of Oman and up the Red Sea, while in August and September the currents are in the reverse direction. Further afield the prevailing ocean currents suggest that this species will probably be found in most parts of the Arabian Sea and possibly over a wider area. As regards the allied species, *H. hayanus*, the general course of the currents would account for its distribution off Singapore and New Guinea, while the North Equatorial current is possibly responsible for its occurrence so far away as the Red Sea.

Concluding Remarks.

The paper by Buchanan White (1883) in the Reports of the " Challenger " Expedition, still forms the basis for the study of the genus *Halobates*. At the time it was written the characters adopted for special diagnoses were sufficient for that purpose but, with the subsequent descriptions of a number of additional species by T. Esaki and others, it has become more difficult to differentiate them solely upon the characters adopted by Buchanan White. Some of the more important features are afforded by the 8th and 9th abdominal

segments together with the genitalia in the male. Most writers have investigated these features superficially while the genitalia have been totally neglected. By following Buchanan White's description only, *H. sewelli* sp. nov. would be regarded as a dark, unicolorous form of *H. hayanus* White. A study of the prepared mounts of the parts in question, however, revealed the obvious distinctness of these two forms.

Without the associated males, the females of many species of *Halobates* are sometimes only to be identified with difficulty. This obvious disadvantage may possibly be overcome by a thorough examination of the minute structure of the ovipositor in each case. Buchanan White neglected this organ, and merely stated that it is composed of two pairs of valves. Nasonov (1897) figures the ovipositor with a similar composition. It remained for Carpenter (1906) to investigate the ovipositor more fully, using the species *H. flaviventris* Esch. (*herdmani* Carp.) for the purpose. He gave reasons for concluding that three pairs of valves are present as in a typical, complete, insect ovipositor. A comparison of the ovipositor in *H. sewelli*, with Carpenter's description of the same organ in *H. flaviventris*, reveals evident differences in the form of the genital operculum and the inner posterior valves. His figures are not, however, sufficiently detailed to make a close comparison. No other writer has studied the character of the ovipositor in this genus. It is necessary, therefore, to emphasize that the matter of separating the females of the species of *Halobates* may ultimately be placed on a surer basis if the structure of the ovipositor be closely examined.

As regards the true morphological interpretation of certain parts of the ovipositor, further work on ample material is needed. In the foregoing account of that organ in *H. sewelli*, it will be noted that the inner appendages (or processes), described by Carpenter as belonging to the anterior valves, are here regarded as integral parts of the inner posterior valves since, upon dissection, they are found to be attached to the latter structures.

In preparing this paper, after an examination of Buchanan White's and other specimens in the British Museum (Natural History), I have become impressed by the need for a thorough revision of the genus *Halobates*. In its absence, confusion is likely to result from the descriptions of further new species if they are based upon the limited range of rather superficial characters, as is at present customary.

I wish to express my indebtedness to Mr. W. E. China for valued assistance, and especially for his dissection of the male genitalia, and associated parts, of Buchanan White's type of *Halobates hayanus* in the British Museum (Natural History). Esaki's statement (1926), that the types of this species are in the Zoological Museum in Berlin, appears to be an error, since, inquiry made by Mr. W. E. China led to the reply that these types are not located there.

LIST OF REFERENCES.

Carpenter, G. H. 1906. On the marine Hemiptera (*Halobates*). Ceylon Pearl Oyster Fisheries : Suppl. Rep. XXXII, pp. 151–156, 1 pl.

Esaki, T. 1926. Halobatinæ in the Hungarian National Museum. Ann. Hist. Nat. Mus. hung. XXIII, pp. 117–164, 12 figs.

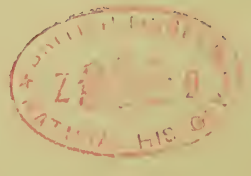
—— 1928. New and little known Gerridæ : I, Ceylonese species. Ann. Mag. Nat. Hist. (10), 11, p. 513.

—— 1930. New and little known Gerridæ from the Malay Peninsula. J.F.M.S. Mus. XVI, p. 17.

Nasonov, N. 1897. Entomological Researches, 1893. Warsaw : Figs. 11 and 12 (in Russian).

Schott, G. 1935. Geographie des Indischen und Stillen Ozeans. Hamburg.

White, F. Buchanan. 1883. Report on the Pelagic Hemiptera. "Challenger" Reports, Zoology, VII, part XIX, 52 pp., 3 pls.



BRITISH MUSEUM (NATURAL HISTORY)

THE

JOHN MURRAY EXPEDITION

1933–34

SCIENTIFIC REPORTS

VOLUME IV, No. 3

NEMERTEA

BY

J. F. G. WHEELER, D.Sc., F.L.S.

(Bermuda Biological Station for Research)

WITH TWO TEXT-FIGURES

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NEMERTEA

BY

J. F. G. WHEELER, D.Sc., F.L.S.

Bermuda Biological Station for Research.

WITH TWO TEXT-FIGURES.

INTRODUCTION.

The Nemerteans collected by the Expedition were two specimens of a littoral form taken with a dredge in shallow water off the Arabian coast, and a single specimen of a pelagic form sorted from the plankton taken in the Indian Ocean. The former proved to be *Amphiporus reticulatus*, Bürger, previously recorded only from the Gulf of Naples; the latter an unknown species described in this report under the name *Nannonemertes indica*.

Order HOPLONEMERTINI, Hubrecht, 1879.

Sub-Order MONOSTYLIFERA, Brinkmann, 1917.

Amphiporus reticulatus, Bürger, 1895.

Two specimens of a small Nemertean (Ne4) were taken at Station 53 on November 2nd, 1933, in 13½ metres, with a triangular dredge. Neither sketch nor note of colour or markings was made. One specimen was sectioned at 10μ (Ne4b), and the anatomical details given below are from this series; the other (Ne4a) was cleared in cedarwood oil, and its identity with Ne4b established from the number and arrangement of the eyespots and the armature.

Both specimens were of the bleached appearance common to almost all preserved Nemerteans, without markings, somewhat flattened, 16–18 mm. long and 1·2–1·5 mm. in width. The specimen sectioned, which was the larger, showed signs of a definite head, marked off from the body by a shallow constriction. In the other specimen the head end could be determined only by clearing, but in both worms the tail was more acutely pointed than the head (Text-fig. 1, A and B). The surface of the bodies showed fine annular wrinkles. When cleared, the eyespots could be seen as brown cup-shaped bodies, eight or ten on each side, while from above the arrangement appeared irregular (Text-fig. 1, C and D). In specimen Ne4a there was a dorsal groove at the head which turned forwards

laterally to the tip of the snout and into which, in the sectioned specimen, the canals of the cerebral organs were found to open.

The epithelium is not very thick, but it is thicker dorsally than ventrally and is thinner at the sides of the body than elsewhere. This holds especially for the anterior sections (Text-fig. 1, E). Posteriorly there is little difference (Text-fig. 1, F). The basement layer is considerably thicker than the circular muscle sheet, and is more conspicuous at the hinder end of the body, where the epithelium is thin. The longitudinal muscles are well developed (Text-fig. 1, E and F).

The mouth opens into the rhynchodæum at the tip of the head, and the narrow œsophagus becomes a capacious stomach between and behind the ganglia. The anterior cæcum branches, the branches extending forward and just overlapping the ends of the cerebral organs (Text-fig. 1, E). There is a head gland, opening dorsally to the rhynchodæum and forming a compact investment to its dorsal muscles. It passes inside the vascular loop and reaches the brain.

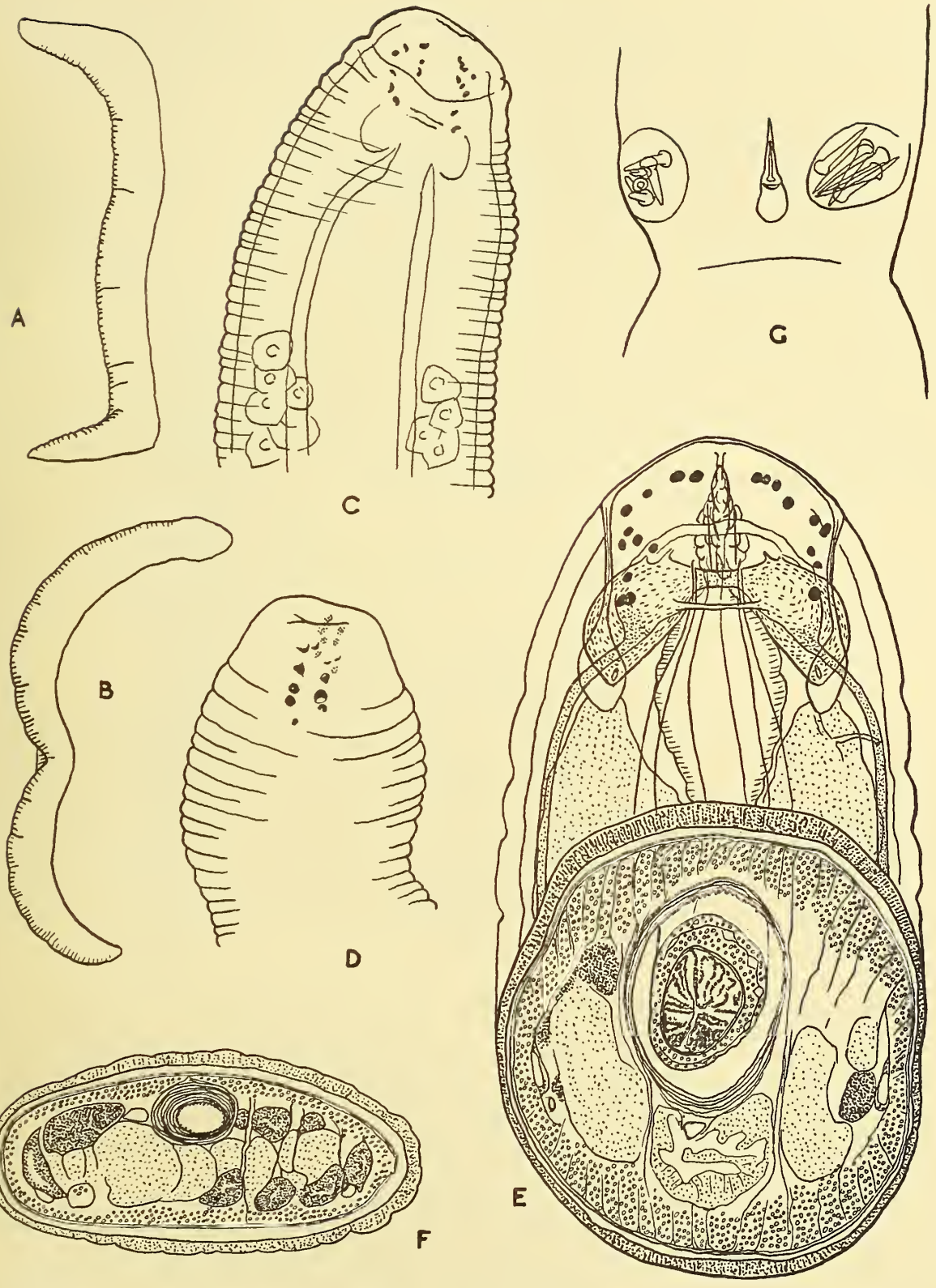
The rhynchocœl extends almost to the tip of the tail. The proboscis is stout (Text-fig. 1, C and E), has ten nerve strands, and is armed with the usual main stylet and two accessory reservoirs of stylets. In specimen Ne4a the main stylet, base and accessory stylets could be seen and measured on clearing. In Ne4b the main stylet was broken on sectioning, but the length of the base could be estimated from the sections and the accessories were still present. The main stylet and accessory stylets (in Ne4a) were of the same length, 0·08 mm., and the base was small, 0·045 mm. There were six accessories in each reservoir. In Ne4b the accessories were five and six; they were smaller than those of Ne4a, and the base of the main stylet did not appear on more than two consecutive sections, which suggests that its length was not much greater than 20μ, although it had been cut obliquely. The vascular system could not be clearly traced, except the lateral vessels close to the lateral nerves, and a dorsal vessel above the gut, outside the musculature of the rhynchocœl. There is, however, a vascular loop in the head in front of the brain.

On one side a single excretory duct was seen leading to the exterior below the lateral nerve close behind the cerebral organ (Text-fig. 1, E).

The brain is large, with a stout ventral and a thin dorsal commissure. The ventral lobes are considerably smaller than the dorsal and pass into the lateral cords under them. The sections showed a twist of the lateral nerves on leaving the brain that was probably due to strong contraction of the body on fixation. The cerebral organs are large. The canals open laterally near the tip of the snout and pass back along the sides of the dorsal ganglia. As the organs expand they become wedged beneath the ganglia and overlap them posteriorly. They are connected with the ganglia at the hinder ends of the latter (Text-fig. 1, E).

Ne4a was a female, with eggs ripening and almost filling the body for the greater part of its length. Ne4b was a male, also with ripening gonads extending down the body. The gonads develop above and below the gut branches.

The omission of any observation on the colour or marking of these worms in life introduces an element of doubt into their specific identification. They belong to the genus *Amphiporus*, and have distinctive characters in the possession of a head gland and a base to the main stylet smaller than the stylet itself. These characters dispose of an identification with *A. pulcher* (Johnst.) or *A. lactifloreus* (Johnst.)—a possibility suggested by the dubious position of *A. albicans*, Ehrenberg, captured in the Red Sea. McIntosh (1873)



TEXT-FIG. 1.—*Amphiporus reticulatus*, Bürger. A and B, Outline drawings of the two specimens. C and D, Sketches of the heads to show the eyespots. E, Graphical reconstruction of the head of B. F, Transverse section of B, close to the posterior end of the body. G, Armature of A.

wrote: "For some time I was inclined to include the *Amphiporus albicans* of Ehrenberg under the synonyms, as it has many characters in common, but it approaches *A. pulcher* in others, and the arrangement of the eye-specks in his figure is so different that I have struck it off" (p. 158). Joubin (1894) identified it with *A. roseus* (O.F.M.), synonymous with *A. pulcher* (Johnst.), while Bürger admitted the possibility of this identity (1895, p. 13), but later (1904) gave *A. albicans* the rank of a separate species.

As far as it goes the description given above agrees with that of *Amphiporus reticulatus*, Bürger, from the Gulf of Naples: "Kopfende nicht verjüngt, abgerundet, Kopf vom Rumpf deutlich abgesetzt. Rücken braunrot, Bauch hellbraun oder rötlich; Kopffurchen gelb. Mit starker kurzer Kopfdrüse. Mit 16–28 Augen, die jederseits im Kopf 2 Reihen bilden; je ein grösseres flacheres Auge ist unmittelbar vor dem Gehirn gelegen. Der Rüssel enthält 10 Nerven. Dorsale Ganglien doppelt so mächtig wie den ventralen. Das ziemlich kleine Cerebralorgan liegt hinter den dorsalen Ganglien. Stilett ein wenig länger als der dicke, in der Mitte ringförmig eingeschnürte Sockel. Mit 2 Reservestilettaschen, deren jede 4–10 Reservestilette enthält. L. 30–50, Br. 1·5–2 mm." (Bürger, 1904, p. 41). In the absence, therefore, of colour notes, which might have put the identity beyond question, I refer these worms to *A. reticulatus*, Bürger.

Sub-Order POLYSTYLIFERA, Brinkmann, 1917.

Tribe PELAGICA, Brinkmann, 1917.

Nannonemertes, gen. nov.

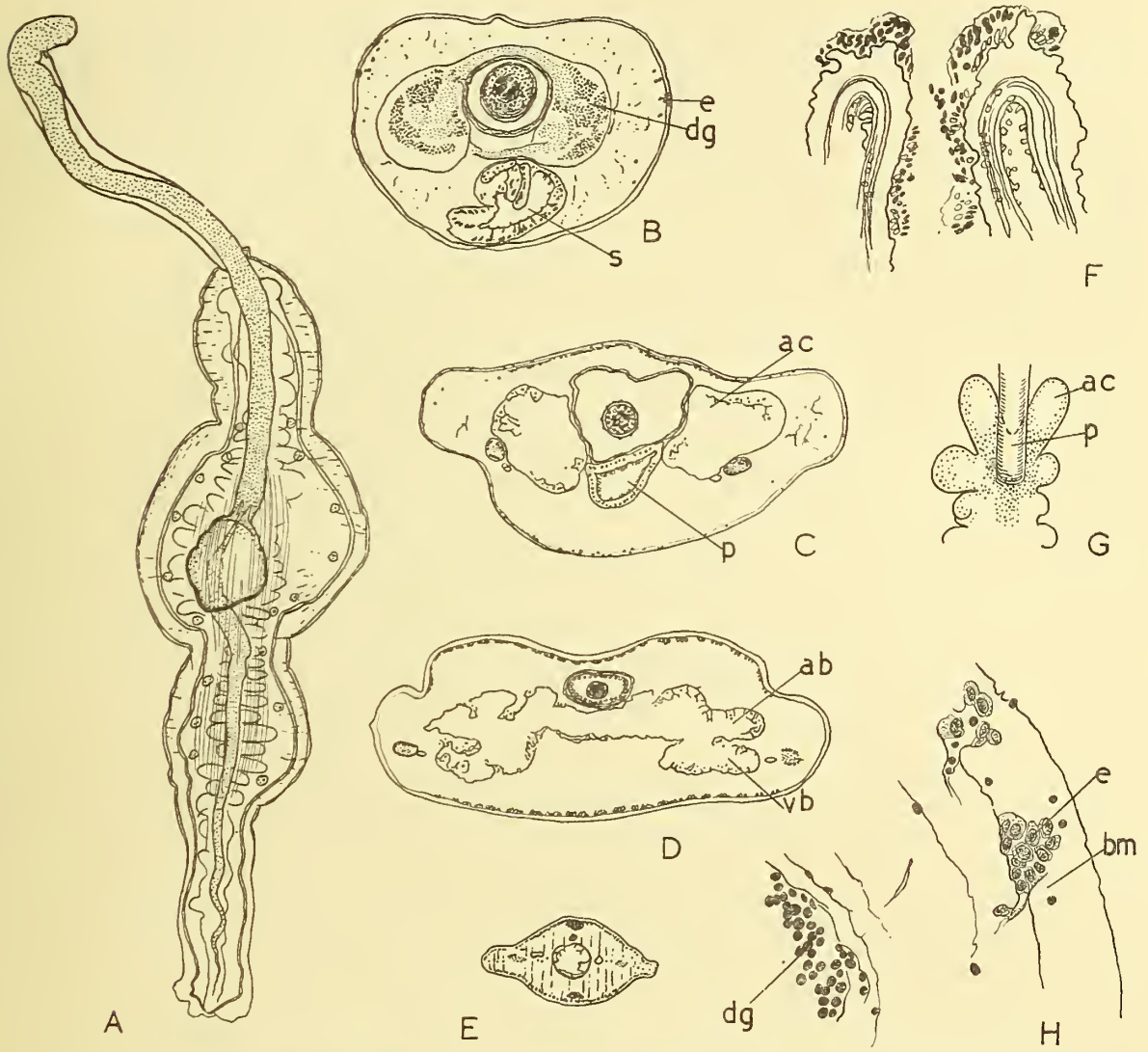
Body hyaline, thin, lanceolate, oval in section anteriorly and flattened posteriorly to a truncated tail. Body muscles extremely reduced. Proboscis-pore terminal. Proboscis relatively stout and at least as long as the body when everted. Rhynchocœl extends throughout the body. Wall of the rhynchocœl formed of inner longitudinal and outer circular muscles. Mouth subterminal, in front of the brain. Gut-branches simple, twenty to twenty-five on each side, the anterior branches with ventral branchlets. Anterior cæcum reduced. Median unpaired sac absent. No lateral nerve muscle-strands. Brain large. Rudimentary eyes present.

Nannonemertes indica, n. sp.

One specimen, an immature female, was taken at Station 131, midway between Zanzibar and Colombo, on February 11th, 1934, with a 1-metre stramin net fished at 1500 metres and hauled open to the surface. It was preserved in formalin with the plankton from the haul and sorted later. No note of the colour was made. After examination it was cleared in cedarwood oil and sectioned completely.

The body is almost transparent, colourless and flattened, 4 mm. long, 1 mm. broad at the broadest part, and about 0·5 mm. thick. In front of the middle the lanceolate outline of the body as seen from above is broken by a swelling, which on clearing is seen to be accompanied by, and probably due to, a dilated region of the rhynchocœl. At the posterior end the edges of the body appear to be flattened somewhat to form the tail. A longitudinal muscle sheet is visible dorsally and ventrally, as a narrow band confined to the middle

region of the body and not extending far laterally. Blunt branches of the gut and the ganglia and lateral nerves can just be seen. The nerves pass down the body laterally to the gut branches. The proboscis is stout (Text-fig. 2, A). Clearing in cedarwood oil showed



TEXT-FIG. 2.—*Nannonemertes indica*, n. sp. A, Outline sketch of the animal before clearing (gonads added to the sketch after clearing). B, Transverse section of the brain region. C, Section showing the pylorus and anterior cæcum. D, Section of the body behind the enlargement. F, Longitudinal section of the tip of the proboscis. G, Diagram showing the pylorus, anterior cæcum and gut. H, Part of a section in the brain region to show the rudimentary eyes. *a.c.*, anterior cæcum; *b.m.*, basement layer; *d.b.*, dorsal branch of gut; *d.g.*, dorsal ganglion; *e.*, rudimentary eye; *p.*, pylorus; *s.*, stomach; *v.b.*, ventral branch of gut.

that the proboscis was fixed with the armature between the ganglia, indicating that the fully everted proboscis would be at least as long as the body. The rhynchocœl reaches almost to the tip of the tail. The dorsal ganglia appear considerably denser than the ventral, and nine small genital sacs can be seen on each side of the body just within the lateral nerves. These are shown in Text-fig. 2, A, although they were not observed before clearing.

There is no epithelium. The basement layer is thin except laterally at the head. In section at the region of the brain there is no visible body musculature, although fibres can be traced in the parenchyma (Text-fig. 2, B). In the mid-body the longitudinal sheets can be seen (Text-fig. 2, C and D), but they do not extend to the sides of the body, and it is only in the tail, where there is a median dorsal and ventral thickening of the longitudinal layer, which here extends into the margins of the body, that the musculature attains some prominence (Text-fig. 2, E). The circular muscle-layer is reduced to isolated fibres. The unstained and featureless parenchyma is very evident, for the gut-branches are neither numerous nor much branched. In the proboscis the number of nerve-strands and the arrangement of the muscles could not be determined, but there is a structureless basement layer ensheathing the muscles and of about the same thickness. The retractor of the proboscis is inserted into the wall of the rhynchocœl near its posterior end. No muscle-layers could be made out in transverse sections of the wall of the rhynchocœl, but at the enlargement, where the sections happen to be frontal, longitudinal fibres predominate and form an inner layer with a sparse investment of circular and diagonal fibres. The position of the armature in the partly extended proboscis was confirmed in the sections, but the armature itself was not seen. There are no lateral nerve muscle-strands such as Bürger described in *Balœnanemertes chuni* (Bürger, 1909), and which are found in the Pelagonemertidæ generally according to Brinkmann (1917, p. 109).

The proboscis-pore and mouth are separate. The former is terminal, the latter subterminal, and just in front of the brain. The mouth opens directly into the stomach, which is lined with ciliated epithelium and possesses numerous deeply-staining gland-cells (Text-fig. 2, B). Further back, in the pyloric region, there are no gland-cells, and the cilia are more evident. The pylorus opens into the gut, which is at this point a capacious chamber, since there is a lateral expansion on each side. Anteriorly, immediately in front of these expansions, two branches of the gut pass forward (anterior cæcum), one on each side of the pylorus and rhynchocœl, and end behind the brain (Text-fig. 2, G). The lateral branches of the gut are blunt pockets which do not reach the lateral nerves. There are twenty to twenty-five on each side, the anterior pockets having dorsal and ventral branchlets (Text-fig. 2, D), the former passing above the gonads where these occur. Some shrinkage may have taken place on fixation, causing swelling and shortening of the gut-branches similar to that demonstrated in *Pelagonemertes* (Wheeler, 1934, p. 286), but I do not think that the pockets overlapped the lateral nerves in life, or that they were much branched. Since the specimen is not mature it is possible that the gut is not yet fully developed.

Lateral vessels have been traced near the lateral nerves, joining behind the brain into a transverse sinus and meeting posteriorly over the end of the gut just in front of the anus. A dorsal vessel has been observed for a short distance along the wall of the rhynchocœl, but neither its origin nor its destination could be seen.

The brain is large (Text-fig. 2, A and B) and shows considerable preponderance of dorsal fibres and nerve-cells over the ventral fibres. Part of the dorsal fibres continue into the lateral nerves to form an ill-defined strand, but I have not been able to trace this far down the body, and I have found no transverse connections between the lateral nerves. The lateral nerves run close to the margins of the body, but are not in contact with the muscles of the body wall.

In the brain region only I have found small patches of nucleated cells beneath the basement membrane (Text-fig. 2, H). There are six or eight on each side, and they appear to

correspond with the organs designated " rudimentary eyes " by Bürger, who discovered them in *Pelagonemertes*. Nine genital sacs, containing immature ova, are present on each side close to the lateral nerves and ventrally to the branches of the gut.

Systematic position.—This animal exhibits a combination of characters diagnostic of different families and cannot be identified with any known species. Chief among these characters are the thin lanceolate outline of the body, with the tail formed partly by flattening and partly by outgrowth ; the extent of the rhynchocœl, and the length of the proboscis ; the size of the brain and the presence of the patches of cells at the head, similar to those described by Bürger as rudimentary eyes ; the extreme reduction of the muscles of the body-wall ; the absence of longitudinal muscle-strands passing down the body with the lateral nerves ; the single branch of the anterior caecum without an unpaired median sac ; the small number of gut-branches and their simple form, with the correspondingly great development of the body-parenchyma, to which is apparently due such rigidity as the body possesses.

The specimen is immature, and doubtless some changes in proportion can be expected with increasing age. Bürger suggests (1909, p. 191) that the number of gut-branches in *Pelagonemertes rollestoni* may vary with the age of the individual. I found, however (1934, p. 286), that the smallest *P. rollestoni* (13·0 cm.) from the South Atlantic possessed sixteen branches on each side, while the largest (35·0 cm.) had fourteen and fifteen. Such differences are probably due to individual variation. There certainly was variation in the proportion of length to breadth among these specimens of *Pelagonemertes*, but the variations showed no progression, which again suggests that such variations are individual and constant through life. The branches of the gut may grow larger with age and perhaps increase in complexity by the formation of branchlets, so that the parenchyma becomes less evident ; and it is probable that, with increase in size of the body, the brain and musculature would also increase. Nevertheless, a large brain and weak muscles in the young are likely to retain their relative size and strength through life. I suggest, therefore, that in the characters mentioned the adult would not differ much from the immature individual described.

The anterior cæcum presents another aspect of the same problem. There is no discernible difference in structure between it and the remaining branches of the gut, and the form corresponds with that in the schematic representation of *Balœnanemertes chuni* Bürger given by Brinkmann (1917, p. 157), that is, the shape of a two-pronged fork. *B. chuni*, from Bürger's drawing (1909, taf. vii, fig. 3), has a large median sac in addition to two lateral branches, *i. e.* it corresponds with *B. lobata*, Joubin, in Brinkmann's diagram. According to Brinkmann reduction of the anterior cæcum accompanies reduction in the number and development of the gut branches. This reduction is almost complete in *Pelagonemertes*, where there is a short median sac only. Brinkmann's statement appears to apply to the form under consideration ; but backward growth of the pylorus and forward growth of the two expansions of the gut, which have been described at the point where the pylorus joins it, would result in a form corresponding with *Balœnanemertes lata*, Brinkmann, *i. e.* the shape of a four-pronged fork. This does not seem improbable in the course of growth. I cannot feel any confidence, therefore, in the form of the anterior cæcum as a specific character, especially in young animals.

The presence of structures similar to the rudimentary eyes of *Pelagonemertes* suggest relationship with this group, but this is precluded by the absence of lateral nerve muscles.

Bürger described these muscle-strands in *Balænanemertes chuni* collected by the " Valdivia " Expedition. He also described the specimens of *Pelagonemertes* collected, but did not remark the muscle-strands; in fact he states: " Die Seitenstammmuskeln von *Balænanemertes* sind Bildungen, die wir bisher bei keiner anderen Nemertine beobachteten " (p. 207). Brinkmann, however, noted their presence in *Pelagonemertes* and the genera included in the family Pelagonemertidæ. He has also found them in *Pendonemertes*, a genus of the family Bathynemertidæ. They are very evident in my sections of the " Discovery " *Pelagonemertes*, but I can find no trace of them in the specimen described here. I must admit that the small size of the specimen is against certainty on this point. Should the muscle-strands be reduced to the thickness of a single muscle-fibre covered by the outer neurilemma, as Coe has described in *Pelagonemertes joubini* (1926, p. 26), nothing less than perfect fixation and sectioning would have disclosed their presence, and until further material is forthcoming this doubt must remain. On other characters *Nannonemertes* stands in close relation to *Pelagonemertes* and *Armaueria*, and it is to the family Pelagonemertidæ, Moseley, that I refer the genus.

LIST OF LITERATURE.

Brinkmann, A. 1917. Die Pelagischen Nemertinen. Bergens Mus. Skr., n.s., iii, No. 1, pp. 1–194, pls. 1–16.

Bürger, O. 1895. Die Nemertinen. Fauna und Flora des Golfes von Neapel, Monog. 22, pp. 1–743, pls. 1–31.

—— 1904. Nemertini. Das Tierreich, XX, pp. 1–151, 15 figs.

—— 1909. Die Nemertinen. Deutsche Tiefsee-Exped. 1898–1899, XVI, 2 Heft, pp. 169–221, pls. 24–36.

Coe, W. R. 1926. The Pelagic Nemerteans. Mem. Mus. Comp. Zool. Harvard, XLIX, pp. 1–244, pls. 1–30, figs. 1–112.

—— 1936. Plankton of the Bermuda Oceanographic Expeditions. VI, Bathypelagic Nemerteans taken in the years 1929, 1930, and 1931. Zoologica, N.Y., XXI, pp. 97–114, fig. 1, pls. 1–10.

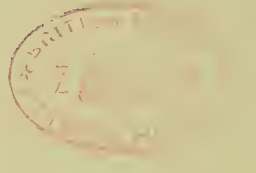
Hemprich, Fr. W., and Ehrenberg, G. 1831. Symbolæ Physicæ. Anim. everteb. exclus. insectis. Ser. prima. Berolini.

Joubin, L. 1894. Les Némertiens. Faune Française, pp. 1–235, pls. 1–4, Paris.

McIntosh, W. C. 1873–74. A Monograph of the British Annelids. Vol. I, Part 1, The Nemerteans, pp. 1–218, pls. 1–23. London.

Punnett, R. C. 1901. Nemerteans. Gardiner's Fauna and Geography of the Maldive and Laccadive Archipelagoes, i, pp. 101–118, pls. 4–5. London.

Wheeler, J. F. G. 1934. Nemerteans from the South Atlantic and Southern Oceans. Discovery Reports, IX, pp. 215–294, pls. 15–16. Cambridge.



11 JAN 1937
PRESENTED

BRITISH MUSEUM (NATURAL HISTORY)

THE

JOHN MURRAY EXPEDITION

1933–34

SCIENTIFIC REPORTS

VOLUME IV, No. 4

CRINOIDEA

BY

AUSTIN H. CLARK

(*National Museum, Washington, D.C., U.S.A.*)

WITH ONE PLATE

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CRINOIDEA

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AUSTIN H. CLARK,

National Museum, Washington, D.C., U.S.A.

WITH ONE PLATE.

The British Museum, through Mr. D. Dilwyn John, has done me the honour of requesting me to report upon the Crinoidea collected by the John Murray Expedition to the Indian Ocean, 1933–1934. The opportunity for studying this collection, so kindly offered, was greatly appreciated, for the Indian Ocean is a region very imperfectly known so far as its crinoids are concerned. Here crinoids are poor in species and few in individuals, and the existing records are far from satisfactory.

The present collection adds much to our knowledge of the systematic status and of the distribution of several species, and by supplementing the information already available, makes it possible for the first time to describe, with the probability of a reasonable degree of accuracy, the faunal interrelationships of the different portions of the Indian Ocean.

The species collected by the Expedition were :

Stephanometra spicata.
S. indica.
Lamprometra klunzingeri.
Colobometra arabica sp. nov.
Oligometra occidentalis.
Tropiometra magnifica sp. nov.
T. audouini.
Crotalometra sentifera.
Cosmiometra leilæ.
Thalassometra attenuata.
Repometra arabica gen. et sp. nov.
Psathyrometra mira.
Caryometra robusta sp. nov.
Fariometra sewelli sp. nov.
Pentametrocrinus varians.
Thaumatocrinus sp.

It is worthy of note that of sixteen species collected, five—roughly 30%—proved to be new, one of these representing a new genus.

All the crinoids known from the Indian Ocean were mentioned in 'The Crinoids of the Indian Ocean' (A. H. Clark, 1912*c*), and all the comatulids were included in 'The Unstalked Crinoids of the "Siboga" Expedition' (A. H. Clark, 1918). All the crinoids known from the African coasts are given in 'The Recent Crinoids of the Coasts of Africa' (A. H. Clark, 1911*a*). Since these contributions appeared a number of additional records have been published, and certain changes have been made in the synonymy of some of the species. It has seemed advisable, therefore, to include herein a list of all the crinoids at present known from the seas west of Ceylon and the west coast of India.

ANNOTATED LIST OF SPECIES.

Suborder OLIGOPHREATA A. H. Clark.

Superfamily MARIAMETRIDA Gislén.

Family Mariametridæ A. H. Clark.

Stephanometra spicata (P. H. Carpenter).

Antedon spicata, P. H. Carpenter, 1881, p. 190.
Stephanometra spicata, A. H. Clark, 1918, p. 95.

Locality.—Station 10 ; Red Sea ; 55 metres. One specimen.

Range.—From the Macclesfield Bank and the Philippine Islands to the Pelew and Caroline Islands, New Guinea, the Admiralty and Solomon Islands, Fiji, the Loyalty Islands and Torres Straits, and westward to the Red Sea ; from the shore-line down to 55 (? 64) metres.

Notes.—The specimen has 20 arms 105 mm. long. The two remaining cirri have 18 and 20 segments ; the longest is 16 mm. long. P_3 may resemble P_2 and be of the same size, though usually it is smaller, or it may be more or less reduced and weak, resembling, or approximating in appearance, P_4. P_2 is composed of 17 segments, and is slender and delicate distally instead of stout and spine-like as usual. This specimen is more or less intermediate between *spicata* and *indica*, though more like the former.

Remarks.—This is the first record for this species in the Red Sea.

Stephanometra indica (E. A. Smith).

Comatula indica, E. A. Smith, 1876, p. 406 ; 1879, p. 564, pl. 51, figs. 3 *a*, *b*.
Antedon marginata, Chadwick, 1908, p. 45.
Stephanometra indica, A. H. Clark, 1918, p. 97.

Localities.—Station 10 ; Red Sea ; 55 metres. Fragments of two specimens.

M.B.*Id.*—Red Sea ; 26 metres. One specimen.

Range.—From the Macclesfield Bank and the Philippine Islands to the Caroline and Marshall Islands, Samoa, Fiji, the Tonga Islands, New Caledonia, and Torres Straits, and westward to Madagascar, the Seychelles, and the Red Sea ; from the shore-line down to 62 (? 73) metres.

There are two forms of this species—typical *indica*, which occurs in the western Indian Ocean, at Ceylon, and in Torres Straits, and an eastern form, *protectus*, in which P_2 is stouter and stiffer, with fewer segments, which is found from Ceylon eastward. The two forms are found together at the Maldive Islands and Ceylon, and in Torres Straits.

Notes.—The specimen from Station M.B.*Id.* has 20 arms ; the cirri have 17–18 segments ; P_2 is 7 mm. long, with 14–16 segments, and becomes slender and delicate terminally ; on one arm P_3 resembles P_2. The two other examples are represented only by arm fragments and a detached disc.

Remarks.—Originally described in 1876 by Mr. E. A. Smith from a specimen collected by Mr. H. H. Slater at Rodriguez, this species was later (1908) recorded by

Mr. H. C. Chadwick from Suez Bay under the name *marginata*, and again (1909) by Prof. F. Jeffrey Bell from north reef, Farquhar Atoll, under the name *palmata*. In 1911 and 1912 I added several more localities to its known range. I have personally examined all the known specimens of the species.

Heretofore two closely related species, *Stephanometra indica* (E. A. Smith) and *S. protectus* (Lütken) (= *Antedon monacantha* Hartlaub) have been recognized. Since both occur together at Ceylon and in Torres Straits, and intergrading specimens are found, I believe that these represent simply two forms of a single variable specific type.

The more generalized form, *indica*, occupies the entire western portion of the range of the species, and is also found on the south central limit of the range (northern Australia). Over the remaining portion of the range only the more specialized form, *protectus*, occurs. Though very variable, this is always readily distinguishable from *indica*.

Lamprometra klunzingeri (Hartlaub).

Comatula leucomelas, Leuckart, 1833, pp. 387, 390 (*nomen nudum*).
Alecto palmata (in part), J. Müller, 1841, p. 144.
Antedon klunzingeri, Hartlaub, 1890, p. 175 ; 1891, p. 46, pl. 2, figs. 22, 25.

Locality.—Station 56 ; South Arabian coast ; 421 metres. One specimen.

Range.—Red Sea and eastward to Muscat ; the records for Zanzibar and Dar-es-Salaam require confirmation. Littoral.

Notes.—The single specimen is very small.

Remarks.—This is a littoral species, and its occurrence in 421 metres of water is very interesting. There is a possibility that it was swimming at or near the surface and was intercepted by the net. Some crinoids are active swimmers, especially when young, and there are a few records of individuals having been captured in tow-nets in a calm sea.

This species has usually gone under the name of *palmata*. But it is evident from Müller's original description and from the locality he gave (" India," probably the Dutch East Indies) that his species was the common eastern representative of the genus (see *Lamprometra palmata*, p. 100). The next available name is Hartlaub's *klunzingeri*.

Family Colobometridæ A. H. Clark.

Colobometra arabica sp. nov. (Plate I, fig. 2.)

Locality.—Station 10 ; Red Sea ; 55 metres. One specimen.

Characters.—The cirri are 20–23 mm. long with 35–40 segments. The three or four segments before the penultimate have single median dorsal spines, these being paired on the segments preceding. P_1 is small and weak, 5 mm. long, with 14–15 segments. P_2 is 8·5 mm. long, with 14 segments. The pinnules following resemble P_2, but slowly decrease in length.

Remarks.—This new species resembles very closely *C. suavis*, known from a single specimen from the Philippine Islands, but it is easily distinguished by the fact that the spines on the cirri are double until near the tip.

Oligometra serripinna var. *occidentalis* A. H. Clark.

Oligometra serripinna var. *occidentalis*, A. H. Clark, 1911*a*, p. 33.

Localities.—Station 10 ; Red Sea ; 55 metres. Fragments of one specimen.

Station 27 ; Gulf of Aden ; 37 metres. Two specimens.

Station 45 ; South Arabian coast ; 38 metres. Two specimens.

Range.—From the Red Sea and the southern coast of Arabia southward to Mauritius and Cargados Carajos ; 0–55 metres. This form occurs as an occasional variant eastward.

Notes.—The specimen from Station 10 consists of arm fragments from a large individual.

One of the specimens from Station 27 has the arms 55 mm. long and the cirri XIV, 14–15. P_2 has 13 segments, the outer with the prismatic angles very slightly produced. The other specimen from Station 27 has the arms 50 mm. long and the cirri XI, 13–14. P_2 has 12 segments, the outer with a very slight production of the prismatic angles.

Both of the specimens from Station 45 are small, and in both P_a is absent. One of them has the arms 25 mm. long. They are described, in a note made at the time of capture, as having been pulled off red Gorgonids.

Superfamily TROPIOMETRIDA A. H. Clark.

Family Tropiometridæ A. H. Clark.

Tropiometra magnifica sp. nov. (Plate I, fig. 1.)

Locality.—Station 24 ; Gulf of Aden ; 73–220 metres. One specimen.

Description.—The centrodorsal is thick discoidal, 9 mm. in diameter at the base with a broad convex dorsal pole 7 mm. in diameter. The cirrus sockets are arranged in two crowded alternating more or less irregular marginal rows.

The cirri are XXV, 35–37, the longest, about the periphery of the centrodorsal, 60–65 mm. long. The first segment is very short, the second is about three times as broad as long, and those following gradually increase in length to the eighth, which is about as long as broad, and the eleventh, which is somewhat longer than broad. The segments following are similar, the distal becoming slightly shorter, so that the last 12 or 14 are about as long as broad, and the last two slightly broader than long. The segments in the outer half of the cirri are slightly compressed laterally and faintly carinate in the mid-dorsal line. The longer earlier segments may be slightly constricted centrally. The opposing spine is minute and terminal, or altogether absent. The terminal claw is somewhat longer than the penultimate segment, rather stout, and moderately curved.

The radials project slightly beyond the rim of the centrodorsal. Their distal edge is slightly and regularly concave, so that they are about twice as long in the interradial angles as in the midradial line. The IBr_1 are very short, 6–7 times as broad as long, with the proximal and distal edges nearly straight and parallel, and the lateral edges slightly divergent and slightly convex. The IBr_2 (axillaries) are triangular with slightly truncated lateral angles, and aretwice as broad as long. The anterior angle is somewhat greater than a right angle, and is a little grooved at the apex. The lateral borders of the IBr series and first two brachials are straight and are almost or quite in contact with those of their neighbours.

The 10 arms are 265 mm. long. The first brachials are wedge-shaped, about twice as long exteriorly as interiorly, nearly four times as broad as the median length, with the proximal and distal edges straight and parallel and the inner edges united basally, diverging at a right angle distally. The second brachials are similar to the first, but the proximal and distal ends are slightly more oblique. The first syzygial pair (composed of brachials 3 + 4) is oblong, nearly twice as broad as long. The brachials following are wedge-shaped, with the longer side more than twice as long as the shorter, and about twice as broad as the greater length ; after the sixteenth the brachials become triangular, with the proximal and distal edges somewhat sinuous, half again as broad as long. After the proximal fourth of the arm the brachials slowly become shorter, with the ends less oblique, in the middle of the arm being wedge-shaped and twice as broad as long. Distally the obliquity of the ends still further decreases, and terminally the brachials increase in length, becoming as long as broad.

Syzygies occur between brachials 3 + 4 and 9 + 10, from between brachials 11 + 12 to between brachials 15 + 16 (usually between brachials 14 + 15), and distally at intervals of from 6 to 9 (usually 7 or 8) muscular articulations. On one arm syzygies occur between brachials 3 + 4, 6 + 7, 10 + 11 and 15 + 16.

P_1 is 22 mm. long, slender and evenly tapering, composed of 28 segments, of which the first is somewhat broader than long, the second is somewhat longer than broad, and those following slowly increase in length, so that the distal are about twice as long as broad. From the fourth onward the segments have a sharp ridge on the outer side, which is slightly convex in profile and finely and irregularly serrate. The area between this and the sharp ventral ridge is slightly concave.

P_2 is 18 mm. long with 27 segments and resembles P_1.

P_3 is 18 mm. long with 25 segments and resembles the pinnules preceding, as does P_4, which is 18 mm. long, with 26 segments.

P_5 is 19 mm. long with 28 segments and is very slightly stouter than the preceding pinnules.

P_6 is 20 mm. long with 27 segments and resembles P_5. The pinnules following are similar.

P_{25} is 17 mm. long with 27 segments.

The distal pinnules are exceedingly slender, 16 mm. long, with 30 segments, which are very slightly constricted centrally and have slightly serrate distal ends.

The colour in spirits is white with a broad, irregular, and frequently interrupted dorsal band of purple on the division series and arms. The cirri are more or less shaded or spotted with purple, the segments often with purple saddles or spots, and the distal pinnules are more or less blotched with purple.

The colours of the living specimen were noted as being as follows, compared with those of ' Color Standards and Color Nomenclature ' (Ridgway, R., 1912) : " Disc and arms : pale viridine yellow ; dorsal arm stripe : taupe brown."

Remarks.—This fine species is related to *T. afra*, which is found from northern Australia to southern Japan. It is much less stout, with much more slender arms and pinnules and longer brachials, which have more oblique ends. The slenderness and the relatively long brachials give it an appearance quite unlike that of any other species of the genus.

Tropiometra audouini A. H. Clark.

Tropiometra audouini, A. H. Clark, 1912*b*, p. 401 ; 1918, p. 131 (in key) ; 1932, p. 564.

Locality.—Station 53 ; South Arabian coast ; 13·5 metres. One specimen.

Range.—Red Sea, and eastward to Muscat.

Notes.—In the single specimen the cirri are about XX, 18–22. The carination of the arms is vestigial. The colour is dark purple, the division series and first eight or nine brachials with a narrow median yellow line, which beyond is interrupted. Some of the brachials have a narrow lateral longitudinal streak or spot of yellow. The cirri are purple, often with the segments narrowly yellow distally, especially on the ventral side.

Remarks.—The true status of this form is as yet undetermined. It is probably a local race of *T. carinata*.

Family Thalassometridæ A. H. Clark.

Crotalometra sentifera (A. H. Clark).

Thalassometra sentifera, A. H. Clark, 1912*c*, p. 201, fig. 37, p. 202.
Crotalometra sentifera, A. H. Clark, 1918, p. 149 (in key).

Locality.—Station 158 ; Maldive area ; 914 metres. Two specimens.

Range.—Laccadive and Maldive islands ; 914–1265 metres.

Notes.—One of the two specimens has 18 or 19 arms. The cirri are about 40 mm. long with 51–55 segments ; the eighth is a transition segment. On the centrodorsal the pairs of columns of cirrus sockets are separated in the midradial line by a broad and rather deeply concave bare area. The proximal edge of the IBr_1, the proximal and distal edges of the IBr_2 and the proximal edge of the $IIBr_1$ are everted and armed with a few short coarse spines.

The second specimen is similar, with 15 + arms. The longest cirri are 47 mm. long, with 61–63 segments. The transition segment is the eighth. The pairs of cirrus sockets are separated by a broad midradial space. The dorsal pole of the centrodorsal is papillose.

Remarks.—Except for the two above-mentioned specimens this species is known only from two much broken individuals dredged by the Royal Indian Marine Surveying Steamer " Investigator ".

Cosmiometra leilæ A. H. Clark.

Cosmiometra leilæ, A. H. Clark, 1932, p. 565, pl. 20, figs. 18, 19.

Locality.—Station 157 ; Maldive area ; 229 metres. Thirteen specimens.

Range.—From south of Ceylon to the Maldive Islands ; 199–241 metres.

Notes.—Thirteen specimens of this recently described species were dredged by the " Mabahiss ". In one of these the 23 arms are 95–100 mm. long. The cirri are XVIII, 36–39, 30–35 mm. long ; the transition segment is usually the ninth, sometimes the tenth. The division series resemble those of the two original specimens from south of Ceylon, but the elements of the IBr series are often somewhat rugose laterally, with the distal border of the IBr_1, and also the $IIBr_1$, coarsely scalloped laterally.

Another individual has 28 arms 90 mm. long. The division series have a slightly irregular surface.

In an example with 24 arms the dorsal surface of the division series is scarcely modified.

Other specimens have 25, 24, 23, 23, 20 and 15 arms, the last two being small. There are four additional examples.

A note made at the time of capture describes the colour of the specimens, compared with those of ' Color Standards and Color Nomenclature ' (Ridgway, R., 1912) to have been—" Orange with the aboral surface white ".

Remarks.—Heretofore this interesting species was known only from the two specimens dredged by the Royal Indian Marine Surveying Steamer " Investigator " south of Ceylon.

Thalassometra attenuata A. H. Clark.

Thalassometra attenuata, A. H. Clark, 1909*d*, p. 147 ; 1912, p. 204, fig. 38, p. 205 ; 1929, p. 654.

Locality.—Station 143 ; Maldive area ; 797 metres. One specimen.

Range.—Known from south of Karachi, the Maldive area, and off Mozambique ; 797–1398 metres.

Notes.—The arms of the single specimen were probably about 120 mm. long. The cirri are about 45 mm. long and consist of 55 segments, of which the ninth is a transition segment. The interradial pairs of columns of cirrus sockets are narrow, and are widely separated by a broad midradial, deeply concave bare area.

Remarks.—This species was originally described in 1909 from six specimens dredged by the Royal Indian Marine Surveying Steamer " Investigator " south of Karachi in 1398 metres. In 1929 a specimen was recorded that had been secured off Mozambique in 914 metres by the cable repair ship " Lady Denison-Pender " of the Eastern and Associated Telegraph Company. The specimen dredged by the " Mabahiss " represents the third record.

Suborder MACROPHREATA A. H. Clark.

Family Antedonidæ Norman (emended).

Repometra gen. nov.

Diagnosis.—A genus of Antedonidæ, subfamily Thysanometrinæ, in which P_2 resembles P_1 instead of P_3, and the cirri are short and composed of few segments that are not greatly longer than broad, with the distal laterally-flattened and dorsoventrally broadened.

Genotype.—*Repometra arabica* sp. nov.

Repometra arabica sp. nov. (Plate I, figs. 3, 3*a*.)

Locality.—Station 53 ; South Arabian Coast ; 13·5 metres. One specimen.

Description.—The centrodorsal is flattened hemispherical, about three times as broad as high, 1·8 mm. broad at the base, with the broad flat polar area 1·3 mm. in diameter. The cirrus sockets are arranged in three closely-crowded alternating marginal rows.

The cirri are about XXX, 10–12, from 3·7 to 5·0 mm. long. The first two segments are about twice as broad as long, the third is from one-third to one-half again as long as

the median width, and the fourth is about twice as long as the median width. The segments following become gradually shorter, so that the antepenultimate is from one-third to one-half again as long as broad, and the penultimate is about as long as broad. The opposing spine is minute, terminal, and directed outward. The terminal claw is about as long as, or slightly longer than, the penultimate segment, rather stout, and rather strongly and evenly curved, most strongly curved in the shorter cirri. The longer proximal cirrus segments are slightly constricted centrally. The distal half of the cirri is laterally flattened, so that in lateral view the outer half of the cirri is about twice as broad as the proximal half. The cirrus segments are all broadly rounded dorsally.

The radials are even with the edge of the centrodorsal. The IBr_1 are very short, seven or eight times as broad as long, with the proximal and distal edges parallel and the lateral edges strongly convergent and somewhat convex. The IBr_2 (axillaries) are triangular, from one-third to one-half again as broad as long, with the proximal border forming almost a straight line, the anterior edges concave, and the distal angle narrow and rounded at the apex. The lateral angles of the IBr_2 are separated from those of their neighbours by a distance equal to almost the entire width of the ossicle.

The 10 arms are all broken off at the base. The first brachials are wedge-shaped, about three times as long exteriorly as interiorly. The second brachials are irregularly quadrate, more than twice as broad as the median length ; they are somewhat larger than the first brachials. The first syzygial pair (composed of brachials 3 + 4) is broader than long, and is longer interiorly than exteriorly. The next two brachials are oblong, half again as broad as long, and those following are obliquely wedge-shaped, nearly as long as broad. The brachials beyond the fourth have prominent and very finely serrate distal ends.

Syzygies occur between brachials 3 + 4 and 9 + 10.

P_1 is 3 mm. long with 20 segments, which are about as long as broad, the outermost becoming somewhat longer than broad.

P_2 is about 1·7 mm. long with 12 segments and resembles P_1.

P_3 is 2 mm. long with about 13 segments, of which the first, second and third have a triangular dorsal process armed with spines directed obliquely distally, and the second–sixth bear a fusiform gonad.

The pinnules following are similar to P_3.

The colour is pale dull purplish, with a median white band on the division series and arms. The centrodorsal and cirri are white, the latter with broad light purple saddles on the segments, and a dark purple interrupted midventral line.

Remarks.—The single specimen of this species is much broken. However, the species is easily recognizable from the characters given. The subfamily Thysanometrinæ was heretofore known in the Indo-Pacific region only from the single genus *Thysanometra*. The discovery of a second genus in that region is therefore of considerable interest.

Psathyrometra mira A. H. Clark.

Psathyrometra mira, A. H. Clark, 1909*b*, p. 648 ; 1912*c*, p. 235, fig. 43 ; 1918, p. 227.

Locality.—Station 109 ; Zanzibar area ; 640 metres. One specimen.

Range.—From the Postillon Islands to the Andamans, and northward to the Gulf of Martaban ; off Zanzibar ; 338–794 metres.

Notes.—In the single specimen from Station 109 the midradial cirrus socket, between the proximal ends of the two columns, is lacking in two of the radial areas. The specimen is, however, undoubtedly referable to *Ps. mira*.

Caryometra robusta sp. nov. (Plate I, fig. 4.)

Locality.—Station 157 ; Maldive area ; 229 metres. One specimen.

Description.—The centrodorsal is conical with swollen sides and a flattened coarsely papillose dorsal pole, 2 mm. broad at the base and 1·5 mm. high. The cirrus sockets are arranged in three closely crowded columns of two each in each radial area, the median column sometimes consisting merely of a single socket. The sockets in each column alternate with those in the columns on either side. There is no differentiation of the surface of the centrodorsal into radial areas.

The cirri are about XXX, 39–47, 20 mm. long, rather stout and with the distal portion capable of being tightly coiled. The first segment is between three and four times as broad as long, the second is somewhat longer, the third is from half again to twice as broad as long, and those following gradually increase in length to the eighth–tenth (usually the ninth), a transition segment, which is twice as long as broad. The segments following slowly decrease in length so that the outermost are nearly or quite twice as broad as long. The distal dorsal edge of the transition segment is slightly prominent. This feature gradually increases in extent distally, developing, on the last eighteen segments, into a high thin median dorsal process with a broadly rounded crest arising from nearly or quite the entire dorsal surface of the segments. The opposing spine is prominent, long conical, arising from almost or quite the entire dorsal surface of the penultimate segment, its length equal to about half the width of that segment ; it is directed slightly forward. The terminal claw is about as long as the penultimate segment and is slender and moderately curved. As far as the middle or outer third of the transition segment the cirri are dark in colour, with a dull surface, beyond that point white with a highly polished surface.

The radials are short, between eight and ten times as broad as long, with a slightly concave distal edge, and are closely united laterally. In dorsal view at right angles to the arm the IBr_1 are somewhat over twice as broad as their lateral length. They are very deeply incised by a posterior process from the axillaries, so that in the median line they are about as long as the radials. In profile the dorsal surface is seen to extend directly outward at right angles to the axis of the arm. The IBr_2 (axillaries) are shield-shaped, about as long as broad, with an obtuse distal angle and proximally a long rounded swollen process deeply incising the IBr_1. Strongly developed synarthrial tubercles are present.

The 10 arms are 60 mm. long. The first brachials are twice as long exteriorly as interiorly, about twice as broad as the exterior length, and deeply incised by a posterior process from the second brachials, which are roughly shield-shaped, not greatly broader than long. The first syzygial pair (composed of brachials 3 + 4) is about half again as broad as long, and is slightly longer interiorly than exteriorly. The next four brachials are approximately oblong, nearly three times as broad as long, after which the brachials become triangular, about as long as broad, and soon very obliquely wedge-shaped and longer than broad, the length gradually increasing until distally they become about twice as long as broad, and terminally still longer. Beyond the third syzygy the

brachials are constricted centrally and have very finely serrate, though not produced, distal ends.

Syzygies occur between brachials 3 + 4, 9 + 10, and 14 + 15, and distally at intervals of 3 muscular articulations.

P_1 is 6 mm. long, with 12 segments, of which the first is about as long as broad, slightly trapezoidal, the second is about half again as long as broad, and those following are much elongated, becoming five or six times as long as broad distally. The third and following segments have moderately flaring and coarsely spinous distal ends.

P_2 is 5·7 mm. long with 11 segments and resembles P_1.

P_3 is 5 mm. long with 11 segments and resembles the pinnules preceding.

P_4 is 3·2 mm. long with 8 segments and resembles the earlier pinnules.

The colour in spirits is bright yellow, with the cirri beyond the transition segment white.

Remarks.—On the basis of the characters presented by the centrodorsal, cirri and arm bases this new species falls in the genus *Caryometra*, of which the only representative heretofore known, *C. tenuipes*, was dredged off Havana, Cuba, in 386 metres.

It differs markedly from *C. tenuipes* in being larger and stouter, with a shorter centrodorsal on which the cirrus sockets are not arranged so definitely in columns ; in having stouter cirri which have a strongly marked transition segment ; and in possessing strongly developed synarthrial tubercles.

Fariometra sewelli sp. nov. (Plate I, fig. 5.)

Locality.—Station 143 ; Maldive area ; 797 metres. One specimen.

Description.—The centrodorsal is conical with straight sides and a rather sharply rounded papillose apex, 3·5 mm. broad at the base, 2·5 mm. from the rim to the apex, and about 1·7 mm. high. The cirrus sockets are rather small and rather well spaced, evenly distributed in alternating rows. There are about four sockets under each radial.

The radials are even with the rim of the centrodorsal in the midradial line, but extend well up in the interradial angles, where their distal angles are separated by a notch. The IBr_1 are very short, about eight times as broad as the median length, with the distal edge slightly concave in the middle, rather strongly everted and armed with fine spines laterally. The lateral borders are somewhat convergent and slightly convex, and are widely separated from those of their neighbours. The IBr_2 (axillaries) are rhombic, with the two proximal sides slightly and the two distal sides strongly concave ; they are about half again as broad as long ; the distal angle is produced and narrow. The lateral angles of adjacent IBr_2 meet over the broad gap between the lateral borders of the IBr_1, forming a conspicuous pore. The anterior edges and the outer portions of the proximal edge are everted and finely spinous.

The 10 arms are about 50 mm. long. The first brachials are short, nearly or quite three times as broad as the outer (greater) length. The distal border is parallel to the proximal border from the inner distal angle to the midradial line, then turns outward and runs at an angle to the distal outer angle. The distal edge, except in the middle, is everted and finely spinous. The inner edges of adjacent first brachials are united in their proximal halves, the distal halves diverging at a right angle. The second brachials

are irregularly quadrate, slightly broader than long, much larger than the first brachials, with the distal edge thickened, everted, and finely spinous. The first syzygial pair (composed of brachials 3 + 4) is one-third again as long interiorly as exteriorly, with the proximal and distal edges somewhat, and the outer edge strongly, concave, the inner edge straight, and the distal edge thickened, everted, and armed with fine spines. The hypozygal is smaller than the epizygal. The next five brachials are slightly wedge-shaped, somewhat over twice as broad as the median length, somewhat constricted centrally, with produced and finely spinous distal ends. The brachials following are almost or quiet triangular and longer than broad. The distal edges of the brachials, though scarcely produced, are finely spinous.

Syzygies occur between brachials 3 + 4, 9 + 10 and 14 + 15, and distally at intervals of 2 muscular articulations.

P_1 is 10 mm. long with 22–23 segments, of which the first is rhombic, about twice as broad as long, and the next four are similar, slowly increasing in length, with the edge toward the arm tip produced into a high triangular process. The sixth segment is slightly longer than broad, without a carinate process. The segments following increase gradually in length, so that the outer are greatly elongated, about six times as long as the swollen ends. The pinnule is long and very slender, becoming filiform distally. The distal ends of the segments are produced and finely spinous.

P_2 is slightly stouter than P_1, 7 mm. long, with 14 segments, of which the first is rhombic, twice as broad as long, the second is almost triangular, about as long as broad, the third is slightly broader than long, the fourth is slightly longer than broad, and the fifth is half again as long as broad. The segments following are more slender, about three times as long as broad, becoming longer in the very slender distal segments. The third and following segments have everted and spinous distal ends. A large fusiform gonad occupies the entire inner border of the sixth–eighth segments.

Remarks.—This new species is related to *F. dione* from the Moluccas in 724 metres. It differs from *F. dione* in its lower and more sharply conical centrodorsal, the greater spinosity of the elements of the IBr series and lower brachials, and the occurrence of conspicuous triangular processes on the outer side of the earlier segments of P_1.

Family Pentametrocrinidæ A. H. Clark.

Pentametrocrinus varians (P. H. Carpenter).

Eudiocrinus varians, P. H. Carpenter, 1882, p. 496; 1888, p. 81, pl. 7, figs. 3-7; A. H. Clark, 1907, p. 569.
Pentametrocrinus varians, A. H. Clark, 1912*c*, p. 251; 1918, p. 262; H. L. Clark, 1923, p. 235.

Locality.—Station 135; Southern area of the Arabian Sea; 2727 metres. One specimen.

Range.—From southern Japan to the East Indies and westward to east Africa, from the Arabian Sea to South Africa; 660–2727 metres.

Notes.—In the single specimen from Station 135 the lower brachials are rather strongly constricted centrally with prominent ends. This feature, though not so strongly marked, occurs also in other specimens at hand from southern Japan.

Thaumatocrinus sp.

Decametrocrinus sp., A. H. Clark, 1912*c*, p. 248, fig. 47, p. 249.

Locality.—Station 158 ; Maldive area ; 914 metres. Fragments.

Notes.—The material consists of three fragments of arms. The longest, from the outer portion of an arm, is 60 mm. long and 2 mm. broad, and consists of 34 brachials, including 8 syzygial pairs, the latter being separated by 3 or 4 muscular articulations. The brachials are about half again as long as broad with strongly oblique ends, and are rather strongly excavated on the shorter side. The pinnule is attached to the middle of the longer side. Above the pinnule socket the side of the brachial is excavated for the reception of the pinnule when at rest. The pinnules bear along the ventral surface a linear series of small eggs, one to each segment.

Another fragment is 55 mm. long and 2·7 mm. wide at the base. On the eighteenth brachial from the base a short distal portion is regenerated, and on this is a pentagonal axillary bearing two arms, one 12 mm. long with 8 brachials, the other 17 mm. long with 11 brachials. The pinnules on the main portion of the arm are all moniliform ventrally, each bearing a linear series of eggs ; those on the two regenerated arm branches have not as yet developed eggs. The brachials in the main portion of the arm are very obliquely wedge-shaped, almost triangular, somewhat longer than broad, and slightly constricted centrally. The brachials in the two regenerated branches are much longer than broad. The intersyzygial interval is 4 muscular articulations.

The third fragment is a continuation of the left regenerated branch of the preceding. It is 17 mm. long and consists of 11 brachials.

The individual from which these fragments came was a female. The genital pinnules bear on the ventral side a linear series of entirely closed globular sacs, broadly in contact, and completely enclosed exteriorly by large thin plates, one to each segment, giving the ventral surface of the pinnules a moniliform appearance. The transverse septa between the sacs are very thin. Each sac contains a single large egg.

Remarks.—This specimen unquestionably is specifically identical with that represented by the fragments I described under the name of *Decametrocrinus sp.* in 1912. The latter were from " Investigator " Station 124, off the Laccadive Islands (lat. 10° 47′ 45″ N., long. 72° 40′ 20″ E.), in 1285 metres. By a curious coincidence each group of these fragments was dredged with two much broken individuals of *Crotalometra sentifera*. Also both sets of fragments show distal arm division.

Among the known forms the fragments approach most closely in their structure the species of *Thaumatocrinus*, but the structure of the gonads is unique, and it is probable that they will eventually prove to belong to a different, though related, genus.

List of the Crinoids Occurring Along the East Coast of Africa and Eastward to the Maldive Islands and the Persian Gulf.

Family Comasteridæ :

Comatella maculata (P. H. Carpenter) (A. H. Clark, 1911*a*, p. 16 ; 1913*b*, p. 3 ; 1931, p. 112 ; 1932, p. 552) ; Maldives ; Salomon ; Coin Peros ; ranges

eastward to Torres Straits and Bowen, Queensland, New Caledonia, Rotuma, the Caroline and Bonin Islands, and southern Japan ; 0–40 metres.

Capillaster sentosa (P. H. Carpenter) (A. H. Clark, 1913*b*, p. 4 ; 1931, p. 160) ; Maldives ; ranges eastward to the Lesser Sunda Islands, Western Australia, the Moluccas, the Philippines, and southern Annam ; 0–135 metres.

C. multiradiata (Linné) (A. H. Clark, 1913*b*, p. 5 ; 1931, p. 173) ; Maldives ; ranges eastward to Australia (south to Shark Bay on the west and Cape Flattery on the east), the Caroline and Philippine Islands, and Formosa ; 0–292 metres.

C. coccodistoma (P. H. Carpenter) (A. H. Clark, 1911*a*, p. 16, as *multiradiata* ; 1931, p. 212) ; Madagascar and Mauritius ; littoral.

Comissia hartmeyeri A. H. Clark (A. H. Clark, 1931, p. 267) ; Gulf of Suez ; littoral.

C. ignota A. H. Clark (A. H. Clark, 1931, p. 269) ; Seychelles and Amirante Islands ; littoral.

Comaster gracilis (Hartlaub) (A. H. Clark, 1913*b*, p. 12 ; 1931, p. 430) ; Maldives ; ranges eastward to New Britain, Fiji, and the Macclesfield Bank ; 0–55 metres.

Comanthina schlegelii (P. H. Carpenter) (A. H. Clark, 1931, p. 466) ; Maldives ; ranges eastward to northern Australia, the Caroline and Philippine Islands, and Macclesfield Bank ; 0–64 (? 278) metres.

Comanthus wahlbergii (J. Müller) (A. H. Clark, 1911*a*, p. 17 ; 1915, p. 166, pl. 9, fig. 3 ; 1931, p. 588 ; H. L. Clark, 1923, p. 231, pl. 8, fig. 3) ; South Africa from the Tugela River, Natal, to the Cape of Good Hope and Simons Bay ; 0–46 metres.

C. parvicirra (J. Müller) (A. H. Clark, 1931, p. 631) ; Madagascar ; Seychelles ; Mauritius ; Gwada, Baluchistan ; ranges eastward to Australia (south to Fremantle and Moreton Bay), New Caledonia, Fiji, Tonga, the Gilbert, Caroline, Pelew and Bonin Islands, southern Japan and Amoy, China ; 0–110 metres.

Family Eudiocrinidæ :

Eudiocrinus gracilis A. H. Clark (A. H. Clark, 1936, p. 301) ; Maldives ; ranges eastward to the Kei Islands ; 73–89 metres.

Family Himerometridæ :

Himerometra sol A. H. Clark (A. H. Clark, 1913*a*, p. 288 ; 1913*b*, p. 26 ; 1918, p. 73, in key) ; Maldives.

H. persica A. H. Clark (A. H. Clark, 1908, p. 243 ; 1913*a*, p. 289 ; 1918, p. 73, in key) ; Persian Gulf.

Heterometra ater (A. H. Clark) (A. H. Clark, 1911*a*, p. 21) ; Red Sea.

H. savignii (J. Müller) (A. H. Clark, 1911*d*, p. 251 ; 1911*a*, p. 24 ; 1913*b*, p. 27) ; Red Sea and eastward to Muscat ; 0–18 (? 22) metres.

H. producta (A. H. Clark) (A. H. Clark, 1913*b*, p. 23) ; Maldives ; ranges eastward to Singapore.

H. flora (A. H. Clark) (A. H. Clark, 1913*b*, p. 23) ; Maldives.

H. madagascarensis (A. H. Clark) (A. H. Clark, 1911*a*, p. 23) ; Madagascar.

H. reynaudi (J. Müller) (A. H. Clark, 1918, p. 79 ; 1929, p. 638) ; Maldives ; ranges eastward to Burma.

H. joubini A. H. Clark (A. H. Clark, 1911*d*, p. 251 ; 1911*a*, p. 25) ; Zanzibar.

H. gravieri A. H. Clark (A. H. Clark, 1911*d*, p. 251 ; 1911*a*, p. 25) ; Zanzibar.

H. africana (A. H. Clark) (A. H. Clark, 1911*a*, p. 20 ; 1913*b*, p. 24) ; Bagamoyo ; Zanzibar ; Waxin ; Karachi ; Persian Gulf ; 0–88 (? 89) metres.

Family Mariametridæ :

Stephanometra spicata (P. H. Carpenter) (see p. 88).

S. indica indica (E. A. Smith) (Chadwick, 1908, p. 45, as *marginata* ; A. H. Clark, 1911*a*, p. 26, as *marginata* and as *indica* ; 1911*d*, p. 252 ; 1913*b*, p. 29, in part [record for the Maldives is *protectus*]) (see p. 88).

S. indica protectus (Lütken) (see p. 88, under *indica*).

Lamprometra palmata (J. Müller) (A. H. Clark, 1929, p. 641 ; 1932, p. 557) ; Maldive Islands, Gwada, Baluchistan, and the " Arabian Sea " eastward to Torres Straits, the Solomon Islands, New Caledonia, the Tonga, Fiji, Hawaiian, Marshall and Caroline Islands, the Philippines, and Hong Kong ; 0–51 (? 433) metres.

L. klunzingeri (Hartlaub) (Chadwick, 1908, p. 46, as *imparipinna*, p. 47, as *palmata* ; A. H. Clark, 1911*a*, p. 26, as *protectus*, p. 27, as *palmata* and *klunzingeri* ; 1911*d*, p. 253, as *palmata* ; 1913, p. 33, as *palmata* ; 1929, p. 641 ; 1932, p. 558) (see p. 89).

Dichrometra flagellata var. *afra* A. H. Clark (Ludwig, 1899, p. 538 ; A. H. Clark, 1911*a*, p. 27, as *Dichrometra sp.*, p. 28, as *flagellata* ; 1911*d*, p. 254, as *Dichrometra sp.* ; 1913*b*, p. 31 ; 1929, p. 641 ; H. L. Clark, 1923, p. 232, pl. 8, fig. 2, as *Liparometra multicirra*) ; East Africa from Lamu, Kenya, south to Durnford Point, Zululand ; Madagascar ; 0–164 metres.

Family Colobometridæ :

Cenometra emendatrix (Bell) (Bell, 1892, p. 428, pl. 18 ; 1909, p. 20, as *spicata* ; A. H. Clark, 1911*a*, p. 28 ; 1913*b*, p. 33) ; Mauritius and the Seychelles ; 0–71 metres.

Colobometra arabica A. H. Clark (see p. 89).

Cyllometra manca (P. H. Carpenter) (A. H. Clark, 1909*d*, p. 146, as *soluta* ; 1912, p. 157, fig. 22, as *soluta* ; 1918, p. 115, in key, as *soluta*) ; from southern Japan and the Bonin Islands to the Philippine, Kei and Lesser Sunda Islands, and westward to the Persian Gulf ; 22 (? 15)–329 (? 731) metres.

Decametra chadwicki (A. H. Clark) (Chadwick, 1908, p. 44, as *serripinna* ; A. H. Clark, 1911*a*, p. 30 ; 1912, p. 168 ; 1918, p. 125, in key ; Boulenger, 1913, pp. 88, 102, as *serripinna*) ; Suez Bay ; 18 metres.

D. alaudæ A. H. Clark (A. H. Clark, 1911*a*, p. 33 ; 1913*b*, p. 35 ; 1918, p. 117, in key ; 1929, p. 642, pl. 44, fig. 14) ; Cargados Carajos ; 55 metres.

D. taprobanes (A. H. Clark) (A. H. Clark, 1909*b*, p. 641 ; 1913*b*, p. 36 ; 1918, p. 117, in key) ; Ceylon and the Maldive Islands ; 0–58 metres.

D. arabica A. H. Clark (A. H. Clark, 1912*c*, p. 161 ; 1913*b*, p. 36 ; 1918, p. 117, in key) ; Muscat ; littoral.

D. mollis (A. H. Clark) (A. H. Clark, 1909*c*, p. 76 ; 1912*c*, p. 161. fig. 24, p. 162 ; 1913*b*, p. 35 ; 1918, p. 117, in key ; 1929, p. 643) ; Karachi to the Maldive Islands ; littoral.

D. modica A. H. Clark (A. H. Clark, 1911*a*, p. 31, as *möbiusi*, p. 32 ; 1912*b*, p. 382 ; 1912*c*, p. 163 ; 1913*b*, p. 36, as *mœbiusi* ; 1918, p. 118, in key) ; Bagamoyo and Mauritius to the Maldive Islands ; ? Ceylon ; littoral.

Oligometra serripinna serripinna (P. H. Carpenter) (A. H. Clark, 1929, p. 646) ; from the Macclesfield Bank and the Philippine Islands southward to New Guinea and westward to the Pedro Shoal, the Maldive Islands, and Bagamoyo, Tanganyika Territory ; 0–91 (? 183) metres.

O. serripinna var. *electræ* A. H. Clark (A. H. Clark, 1911*a*, p. 51 ; 1912*c*, p. 174 ; 1913*b*, p. 38 ; 1918, p. 129, in key) ; southeast of Massawa, Eritrea ; 38 metres.

O. serripinna var. *occidentalis* A. H. Clark (see p. 90).

Family Tropiometridæ :

Tropiometra magnifica A. H. Clark (see p. 90).

T. carinata (Lamarck) (A. H. Clark, 1911*a*, p. 34 ; p. 35, as *picta* ; 1911*d*, p. 255, as *carinata* and as *picta* ; 1913*b*, p. 39, p. 40, as *picta* ; 1932, p. 564) ; Cargados Carajos, the Seychelles, Farquhar Atoll, Mauritius, Madagascar and Réunion, and the African coast southward and westward to False Bay, Cape of Good Hope ; St. Helena ; from Santa Catarina Island, southern Brazil, northward to St. Lucia, Tobago, Trinidad and Venezuela ; 0–55 metres, but brought up from 508 metres off St. Lucia.

T. audouini A. H. Clark (A. H. Clark, 1911*a*, p. 36, as *encrinus*, in part ; 1929, p. 646 ; 1932, p. 564) (see p. 92).

Family Thalassometridæ :

Crotalometra sentifera (A. H. Clark) (see p. 92).

C. magnicirra (Bell) (A. H. Clark, 1911*a*, p. 36) ; off East London ; 548–823 metres.

Cosmiometra leilæ A. H. Clark (see p. 92).

C. gardineri A. H. Clark (A. H. Clark, 1911*a*, p. 38 ; 1913*b*, p. 43) ; Saya de Malha ; 247 metres.

Thalassometra attenuata A. H. Clark (see p. 93).

Thalassometra sp. nov. (A. H. Clark, 1911*a*, p. 51 ; 1913*b*, p. 70) ; northwest of Sokotra ; 2194 metres.

Family Charitometridæ :

Perissometra occidentalis A. H. Clark (A. H. Clark, 1929, p. 655, pl. 42, fig. 10) ; 120 miles off the Seychelles ; 1462 metres.

Pachylometra sclateri (Bell) (A. H. Clark, 1911*a*, p. 38 ; 1913*b*, p. 48 ; 1918, p. 184, in key, p. 185 ; H. L. Clark, 1923, p. 234) ; off East London, South Africa ; 238 (? 146)–566 metres.

Pachylometra sp. nov. (A. H. Clark, 1911*a*, p. 51 ; 1913*b*, p. 70); northwest of Sokotra ; 2194 metres.

Family Antedonidæ :

Compsometra parviflora A. H. Clark (A. H. Clark, 1918, p. 207 ; 1936, p. 316) ; Maldives and eastward to the Moluccas and the Philippines ; 0–275 (? 400) metres.

Dorometra mauritiana (A. H. Clark) (A. H. Clark, 1911*a*, p. 40 ; 1911*d*, p. 257 ; 1912, p. 405 ; 1918, p. 216) ; Madagascar and Mauritius ; littoral.

D. nana (Hartlaub) (A. H. Clark, 1913*b*, p. 54 ; 1918, p. 215, in key, p. 216) ; Maldives and eastward to northern Australia, the Tonga Islands, the Philippines and Macclesfield Bank ; 0–74 metres.

D. ægyptica (A. H. Clark) (Chadwick, 1908, p. 45, as *parvicirra* ; A. H. Clark, 1911*a*, p. 42 ; 1913*b*, p. 53 ; 1918, p. 215, in key, p. 217) ; Suez Bay ; 18 metres.

Annametra occidentalis (A. H. Clark) (A. H. Clark, 1915, p. 164, pl. 10, figs. 1–5 ; 1929, p. 659 ; H. L. Clark, 1923, p. 231) ; from Durban, Natal, southward and westward to Simons Bay, Cape of Good Hope ; littoral.

Repometra arabica A. H. Clark (see p. 93).

Psathyrometra mira A. H. Clark (see p. 94).

Caryometra robusta A. H. Clark (see p. 95).

Perometra afra A. H. Clark (A. H. Clark, 1911*a*, p. 43 ; 1913*b*, p. 57 ; 1918, p. 234) ; Providence Island, northeast of Madagascar ; 228 metres.

Cyclometra flavescens A. H. Clark (A. H. Clark, 1911*a*, p. 51 ; 1913*b*, p. 62) ; northwest of Sokotra ; 2194 metres.

Fariometra sewelli A. H. Clark (see p. 96).

Thaumatometra sp. nov. (A. H. Clark, 1911*a*, p. 51 ; 1913, p. 71) ; northwest of Sokotra ; 2194 metres.

Family Pentametrocrinidæ :

Pentametrocrinus varians (P. H. Carpenter) (see p. 97).

Pentametrocrinus sp. (Chun, 1900, p. 488, as *Eudiocrinus*, sp. nov. ; A. H. Clark, 1911*a*, p. 49) ; off Somaliland ; 1289 metres.

Thaumatocrinus sp. A. H. Clark (see p. 98).

Family Bathycrinidæ :

Bythocrinus chuni (Döderlein) (Chun, 1900, p. 488, as *Rhizocrinus sp.* ; Döderlein, 1907, p. 14, fig. 6, pl. 1, fig. 5, pl. 6, fig. 6 ; 1912, p. 14, pl. 3 ; H. L. Clark, 1923, p. 229) ; from Somaliland southward to South Africa ; 1644–1828 metres.

Monachocrinus cœlus H. L. Clark (H. L. Clark, 1923, p. 229, pl. 8, fig. 1) ; South Africa ; 1645–1828 metres.

[Note.—*Antedon impinnata* P. H. Carpenter from Mauritius is an immature individual that has not yet acquired the full complement of proximal pinnules. The species cannot be determined from the meagre description.]

The Fauna of the Indian Ocean and the Red and Arabian Seas.

From the Indian Ocean west of Ceylon and the west coast of India, and the Arabian and Red Seas, there have been recorded 69 species and forms of crinoids, which are distributed among the several families as follows: Comasteridæ, 10; Eudiocrinidæ, 1; Himerometridæ, 11; Mariametridæ, 6; Colobometridæ, 12; Tropiometridæ, 3; Thalassometridæ, 6; Charitometridæ, 3; Antedonidæ, 12; Pentametrocrinidæ, 3; and Bathycrinidæ, 2.

No representatives of the families Zygometridæ, Calometridæ, Ptilometridæ, Asterometridæ, Notocrinidæ, Atelecrinidæ, Pentacrinidæ, Proisocrinidæ, Phrynocrinidæ, Hyocrinidæ or Holopodidæ, or of the subfamily Comactiniinæ of the Comasteridæ or of the subfamily Heliometrinæ of the Antedonidæ, have been taken in this area.

It is probable that the Zygometridæ and Comactiniinæ, including shallow-water types usually common in the regions where they occur, are really absent. The polar and east Pacific Heliometrinæ, the south Australian Ptilometridæ, the Antarctic Notocrinidæ and the Caribbean Holopodidæ also probably do not occur. Representatives of the Calometridæ, Atelecrinidæ, Pentacrinidæ, Proisocrinidæ, Phrynocrinidæ and Hyocrinidæ, and possibly of the Asterometridæ, will probably be found as the region becomes better known.

The crinoid fauna of the Indian Ocean is simply the progressively depauperate western extension of the very rich fauna that has its centre in the region of the large Malayan islands. This fauna extends northward along the western side of the Malay peninsula, and also reaches the Andaman Islands. Thence it extends across the Bay of Bengal to Ceylon, where, however, a number of its characteristic elements appear to be missing. West of Ceylon it reaches, in a still more attenuated form, the Maldive Islands, where no less than twelve wide ranging Malayan types reach their western limit. These are:

Capillaster sentosa.
Capillaster multiradiata.
Comaster gracilis.
Comanthina schlegelii.
Eudiocrinus gracilis.
Heterometra producta.
Heterometra reynaudi.
Stephanometra protectus.
Lamprometra palmata.
Decametra taprobanes.
Compsometra parviflora.
Dorometra nana.

Together with these should be grouped *Himerometra sol*, *Heterometra flora*, *Decametra mollis*, *Crotalometra sentifera*, *Cosmiometra leilæ* and *Fariometra sewelli*, all of which are obviously closely related to forms found further east.

It was, on the other hand, in this region of the Indian Ocean that the John Murray Expedition found a representative of the genus *Caryometra* previously known only from the Caribbean Sea (see p. 96), a discovery especially interesting in view of the recent description of *Psathyrometra acuta*, dredged off Puerto Rico, allied to *Ps. mira*, and representing a genus supposed to be confined to the Indo-Pacific region and the west coast of North and Central America.

In the Persian Gulf we find *Himerometra persica*, of which the Malayan *H. bartschi* is probably only a larger form, and the wide-ranging *Cyllometra manca*. The Persian Gulf may therefore be considered as the western limit of the Malayan fauna in the Arabian Sea, corresponding in this respect to the Maldive Islands further south.

Southwestward from the Maldive Islands the Malayan fauna, becoming still more attenuated, reaches the Seychelles, Rodriguez, Mauritius, Réunion, Madagascar and the opposite coast of Africa. A definite modification is now evident. The few endemic species are either small and slender, with slender proximal pinnules, or they are small, slender, and slender-pinnuled representatives of typically larger and stouter types. In most cases they differ more or less widely from the corresponding, or most closely related, forms occurring further eastward. But the differences are due to further depauperization. No new faunal types appear. Here we find :

Comatella maculata.
Capillaster coccodistoma.
Comissia ignota.
Comanthus parvicirra.
Heterometra madagascarensis.
H. joubini.
H. gravieri.
H. africana.
Stephanometra indica.
Dichrometra afra.
Cenometra emendatrix.
Decametra alaudæ.
D. modica.
Oligometra serripinna.
O. occidentalis.
Tropiometra carinata.
Cosmiometra gardineri.
Perissometra occidentalis.
Dorometra mauritiana.
Psathyrometra mira.
Perometra afra.

North of Zanzibar and west of the Persian Gulf the fauna becomes still more attenuated. Species are few and individuals apparently localized and uncommon—at least no large number of individuals of any species has ever been secured anywhere. The local forms are all slender and usually small representatives of corresponding Malayan types, and all are remarkable for their slender proximal pinnules. All of them differ from their immediate relatives at Ceylon or further eastward, though some of them—*Stephanometra indica*, *Oligometra occidentalis*, *Thalassometra attenuata* and *Bythocrinus chuni*—occur in the region between the Maldive Islands and south-eastern Africa. The inclusion in the following list of *Stephanometra spicata* and of *Pentametrocrinus varians* is no real exception to this statement, for the single specimen of each in the collection differs in certain particulars, quite likely to prove of varietal or subspecific importance when additional material is available, from typical examples from the Malayan area. The forms occurring in this region are :

Comissia hartmeyeri.
Heterometra ater.
H. savignii.
Stephanometra spicata.
S. indica.
Lamprometra klunzingeri.
Colobometra arabica.
Decametra chadwicki.
D. arabica.
Oligometra electræ.
O. occidentalis.
Tropiometra magnifica.
T. audouini.
Thalassometra attenuata.
Thalassometra sp.
Pachylometra sp.
Dorometra ægyptica.
Repometra arabica.
Cyclometra flavescens.
Thaumatometra sp.
Pentametrocrinus varians.
Pentametrocrinus sp.
Bythocrinus chuni.

Of the forms included in the preceding list *Repometra arabica* and *Cyclometra flavescens* are both known only from single individuals, and both represent genera known nowhere else. They would appear, therefore, to contradict the statement that no new faunal types appear in this region. *Repometra arabica* is very small. Crinoids so small as this are seldom recovered from the material brought up by the dredge. It should be disregarded in a discussion of faunal relationships. *Cyclometra flavescens* was brought up from very deep water together with *Thalassometra sp.*, *Pachylometra sp.*, and *Thaumatometra sp.* With these wide-ranging associates, the genus *Cyclometra* cannot be assumed to be absent from the seas further east ; indeed, it is rather closely related to the Japanese *Boleometra clio*, which until recently was included in *Cyclometra*.

South Africa, from Natal southward and including the south-western coast as far north as Saldanha Bay, has a fauna of its own characterized by two distinctive elements. The crinoids known from this region are :

Comanthus wahlbergii.
Tropiometra carinata.
Crotalometra magnicirra.
Pachylometra sclateri.
Annametra occidentalis.
Pentametrocrinus varians.
Bythocrinus chuni.
Monachocrinus cœlus.

Comanthus wahlbergii shows the closest affinity with *C. trichoptera*, *C. benhami*, *C. tasmaniæ* and *C. novæzealandiæ* of southern Australia, Tasmania and New Zealand. It is quite different from any of the Indo-Pacific species of the genus. *Annametra occidentalis* has as its only close relative the very different *A. minuta* of southern Japan.

Pentametrocrinus varians is a wide-ranging Indo-Pacific species, and *Crotalometra magnicirra* and *Pachylometra sclateri* are local species of wide-ranging deep-water Indo-Pacific genera. *Bythocrinus chuni* and *Monachocrinus cœlus* are local representatives of genera widely distributed both in the Indo-Pacific region and in the Atlantic.

Tropiometra carinata offers a most interesting faunal anomaly. It occurs among the islands in the western Indian Ocean, from Kenya southward to the Cape of Good Hope, at St. Helena, and from southern Brazil northward to Venezuela and the southern West Indies. It is everywhere littoral, except at St. Lucia. Like so many wide-ranging animals, it is usually common, or even abundant, wherever it is found. It is equally abundant at Mauritius, Zanzibar, Rio de Janeiro, Tobago and St. Lucia, in all of these places being by far the commonest crinoid. It is very common at other localities also. It is the only crinoid common to the islands in the western Indian Ocean, south-eastern and southern Africa, St. Helena, and the western tropical Atlantic. Its range does not coincide with any faunal region as delimited by other littoral crinoids, but extends over three more or less distinct faunal regions. Closely related to this, perhaps merely local forms of it, are *T. audouini* of the Red Sea region, *T. indica* of Ceylon, and the larger *T. encrinus* of the eastern coast of India. The two other species of the genus are the very large and stout *T. afra* occurring from southern Japan to Australia, and the almost equally large, but curiously slender, *T. magnifica* from the Gulf of Aden.

Stated briefly, the faunal conditions in the Indian Ocean, so far as the littoral and shallow-water crinoids are concerned, are these : The Malayan fauna, little changed except for the absence of a number of characteristic species, extends across the Bay of Bengal to Ceylon and, with the loss of additional species, to the Maldive Islands and the Persian Gulf. Becoming still more attenuated, the Malayan fauna extends south-westward along

the islands of the western Indian Ocean to south-eastern Africa. In this region all the large species are absent and many of the others have become modified in the direction of a decrease in size and stoutness, combined with greater slenderness of the proximal pinnules. North of Zanzibar and Madagascar and west of the Persian Gulf the fauna becomes still poorer. The relatively few local forms, all of which appear to be uncommon, are all slender and usually small representatives of corresponding Malayan types. All of them differ from their relatives occurring in Ceylon and further eastward, though some live among the islands to the southward.

South Africa from Natal southward has its own special fauna, characterized by two littoral endemic species that are quite different from any Malayan forms. The third littoral species ranges north-eastward to Cargados Carajos, but the group of species to which it belongs is not represented east of Ceylon and the eastern coast of India.

BIBLIOGRAPHY.

The following titles include all the contributions of immediate interest in connection with the crinoid fauna of the Indian Ocean and the Red and Arabian Seas. A full list of titles, covering the entire Indo-Pacific area, will be found in A. H. Clark, 1912*c*, and a supplementary list is given in A. H. Clark, 1936.

All of the crinoids of this region, except those first described herein, are included in the keys to genera and species given in A. H. Clark, 1918.

Audouin, Victor. 1817.* Explication sommaire des planches d'échinodèrmes de l'Égypte et de la Syrie, publiée par Jules-César Savigny ; offrant un exposé des caractères naturels des genres avec la distinction des espèces. Description de l'Égypte, XXIII [Crinoids on pp. 1–5, pl. 1].

Bell, F. Jeffrey. 1884. Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. " Alert ", 1881–2 [Crinoidea, pp. 153–177, 510–511, pls. 10–17].

—— 1892. Description of a New Species of *Antedon* from Mauritius. Ann. Mag. Nat. Hist., ser. 6, IX, pp. 427–428, pl. 18.

—— 1902. The Actinogonidiate Echinoderms of the Maldive and Laccadive Islands. Fauna and Geography of the Maldive and Laccadive Archipelagoes. Edited by J. S. Gardiner. I, pp. 223–233.

—— 1905. On the Echinoderma found off the Coast of South Africa. Part IV : Crinoidea. Mar. Invest. S. Afr. IV, pp. 139–142, pls. 2–4.

—— 1909. Report on the Echinoderma (other than Holothurians) Collected by Mr. J. Stanley Gardiner in the western parts of the Indian Ocean. Trans. Linn. Soc. Lond. Zool., ser. 2, XIII, pp. 17–22, pl. 3.

Boulenger, C. L. 1913. Report on the Myzostomida Collected by Mr. Cyril Crossland in the Red Sea in 1905. Proc. Zool. Soc. Lond., pp. 85–108, pls. 5–8.

Carpenter, P. Herbert. 1881. The Comatulæ of the Leyden Museum. Notes Leyden Mus. III, pp. 173–217.

—— 1882. Descriptions of New or Little-known Comatulæ. I : On the Species of *Atelecrinus* and *Eudiocrinus*. II : The Comatulæ of the Hamburg Museum. J. Linn. Soc. (Zool.) XVI, pp. 487–526.

—— 1888. Report on the Crinoidea Collected during the Voyage of H.M.S. " Challenger ". Part II : The Comatulæ. " Challenger " Reports, Zoology, XXVI, part 60, pp. ix, 399, 70 pls., text-illust.

Chadwick, Herbert C. 1908. Reports on the Marine Biology of the Sudanese Red Sea. VII : The Crinoidea. Journ. Linn. Soc. (Zool.) XXXI, pp. 44–47 ; November.

Chun, C. 1900. Aus den Tiefen des Weltmeeres. Schilderungen von der deutschen Tiefsee-Expedition. Jena, pp. vi, 549, 46 pls., 2 maps.

* Sherborn in ' Proc. Zool. Soc.,' 1897, p. 287, quotes *1826* as the date of this part.

Clark, Austin Hobart. 1907. On a Collection of Crinoids of the Genus *Eudiocrinus* from Japan, with Description of a New Species. Proc. U.S. Nat. Mus. XXXII, pp. 569–574; June 15th.

—— 1908. Notice of Some Crinoids in the Collection of the Museum of Comparative Zoology. Bull. Mus. Comp. Zool. Harvard, LI, pp. 233–248, pls. 1, 2; January.

—— 1909*a*. Red Sea Crinoids [a review of Chadwick, 1908]. Amer. Nat. XLIII, pp. 253–256; April.

—— 1909*b*. Descriptions of Seventeen New Species of Recent Crinoids. Proc. U.S. Nat. Mus. XXXVI, pp. 633–651; June 19th.

—— 1909*c*. New Recent Crinoids from the Indian Ocean. Proc. Biol. Soc. Wash. XXII, pp. 75–86; April 17th.

—— 1909*d*. New Recent Indian Crinoids. Proc. Biol. Soc. Wash. XXII, pp. 143–152; June 25th.

—— 1911*a*. The Recent Crinoids of the Coasts of Africa. Proc. U.S. Nat. Mus. XL, pp. 1–51; March 15th.

—— 1911*b*. The Recent Crinoids of the Leyden Museum. Notes Leyden Mus. XXXIII, pp. 175–192; April.

—— 1911*c*. A New Crinoid Genus from the Indian Ocean. Proc. Biol. Soc. Wash. XXIV, pp. 87–88; May 15th.

—— 1911*d*. Notes sur les crinoïdes actuels du muséum d'histoire naturelle de Paris. Bull. Mus. Hist. Nat., Paris, pp. 243–260, figs. 1, 2.

—— 1912*a*. The Crinoids of the Natural History Museum at Hamburg. Smithson. Misc. Coll. LX, No. 10, pp. 1–33; November 7th.

—— 1912*b*. The Crinoids of the Museum für Naturkunde, Berlin. Proc. U.S. Nat. Mus. XLIII, pp. 381–410; November 20th.

—— 1912*c*. The Crinoids of the Indian Ocean. Echinoderma of the Indian Museum. Part VII: Crinoidea, pp. i–iii, 1–325, text-figures 1–61 [Bibliography, pp. 290–309]; November 22nd.

—— 1913*a*. Revision of the Crinoid Genus *Himerometra*. Proc. U.S. Nat. Mus. XLVI, pp. 279–289; November 25th.

—— 1913*b*. Notes on the Recent Crinoids in the British Museum. Smithson Misc. Coll. LXI, No. 15, pp. 1–89; December 31st.

—— 1915. Die Crinoiden der Antarktis. Deutsche Südpolar-Expedition 1901–1903, XVI. Zoologie VIII, pp. 103–209, pls. 2–10 [African Crinoids, pp. 163–168, pls. 9, 10]; May 16th.

—— 1918. The Unstalked Crinoids of the "Siboga" Expedition, 1899–1900. "Siboga" Exped. XLII b, pp. 1–300, pls. 1–9, 11–28, text-figs. 1–17; March.

—— 1929. On Some Recent Crinoids in the Collection of the British Museum. Journ. Linn. Soc. (Zool.) XXXVI, pp. 635–664, pls. 40–44; May 3rd.

—— 1931. A Monograph of the Existing Crinoids. Vol. I: The Comatulids; Part 3, Superfamily Comasterida. Bull. U.S. Nat. Mus. 82, I, part 3, pp. i–vii, 1–816, pls. 1–82; March 21st.

—— 1932. On a Collection of Crinoids from the Indian Ocean and the Bay of Bengal. Rec. Indian Mus. XXXIV, pp. 551–566, pls. 19–20; December.

—— 1936. Biological Results of the "Snellius" Expedition. I: The Unstalked Crinoids of the "Snellius" Expedition. Temminckia, I, pp. 295–320, pls. 7–9.

Clark, Hubert Lyman. 1923. The Echinoderm Fauna of South Africa. Ann. S. Afr. Mus. XIII, pp. 221–435, pls. 8–23 [Crinoidea, pp. 227–235, pl. 1]; May.

Decken (Carl Claus von der), Baron. 1869. Baron C. C. von der Decken's Reisen in Ost Africa in 1859–61. . . . Bearbeitet von W. C. H. Peters. Leipzig and Heidelberg, 1869–79 [Crinoidea, by E. von Martens, in III, Abt. 1, pp. 125–134, 1 pl.].

Döderlein, L. 1907. Die gestielten Crinoiden der "Siboga"-Expedition, 1899–1900. "Siboga" Exped. XLII a, pp. 1–54, pls. 1–23, 12 text-figs; November.

—— 1911. Die gestielten Crinoiden der Deutschen Tiefsee-Expedition. Wiss. Ergebn. "Valdivia" 1898–1899, XVII, Heft 1, pp. 1–34, pls. 1–12, 9 text-figs; November.

Fox, H. M. 1926. (See under Mortensen, Th., 1926.)

Hartlaub, Clemens. 1890. Beitrag zur Kenntniss der Comatuliden-fauna des indischen Archipels. Vorläufige Mittheilung. Nachr. Ges. Wiss. Göttingen, Mai, pp. 168–187.

—— 1891. Beitrag zur Kenntniss der Comatuliden-fauna des Indischen Archipels. Nova Acta Leop. Carol. LVIII, No. 1, pp. 1–120, pls. 1–5.

Leuckart, F. S. 1833. Einiges über das Asteroiden-Geschlecht *Comatula*, Lam., überhaupt, und über *Comatula mediterranea* insbesondere. Z. organ. Physik, III, pp. 375–391.

Loriol, Percival de. 1894. Catalogue raisonné des échinodèrmes recueillis par M. V. de Robillard a l'île Maurice. III: Ophiurides, Astrophytides et Crinoïdes. Mem. Soc. Phys. Genève, XXXII, Pt. 1, No. 3, pp. 1–64, pls. 23–25.

Ludwig, Hubert. 1899. Echinodermen des Sansibargebietes. Abh. senckenb. naturf. Ges. XXI, pp. 537–563.

Mortensen, Th. 1926. Cambridge Expedition to the Suez Canal, 1924. VI : Report on the Echinoderms [with an appendix by H. M. Fox]. Trans. Zool. Soc. Lond. XXII, pp. 117–131 ; December.

Müller, Johannes. 1841. Ueber die Gattungen und Arten der Comatulen. Mber. preuss. Akad. Wiss., pp. 179–189 ; also Arch. Naturgesch. I, pp. 139–148.

—— 1849. Ueber die Gattung *Comatula*, Lam., und ihre Arten. Abh. preuss. Akad. Wiss., 1847, pp. 237–265.

Smith, Edgar A. 1876. Diagnoses of New Species of Mollusca and Echinodermata from the Island of Rodriguez. Ann. Mag. Nat. Hist., ser. 4, XVII, p. 406.

—— 1879. Zoology of Rodriguez : Echinodermata ; Crinoida. Philos. Trans. CLXVIII (extra volume), pp. 564–568, pl. 51.

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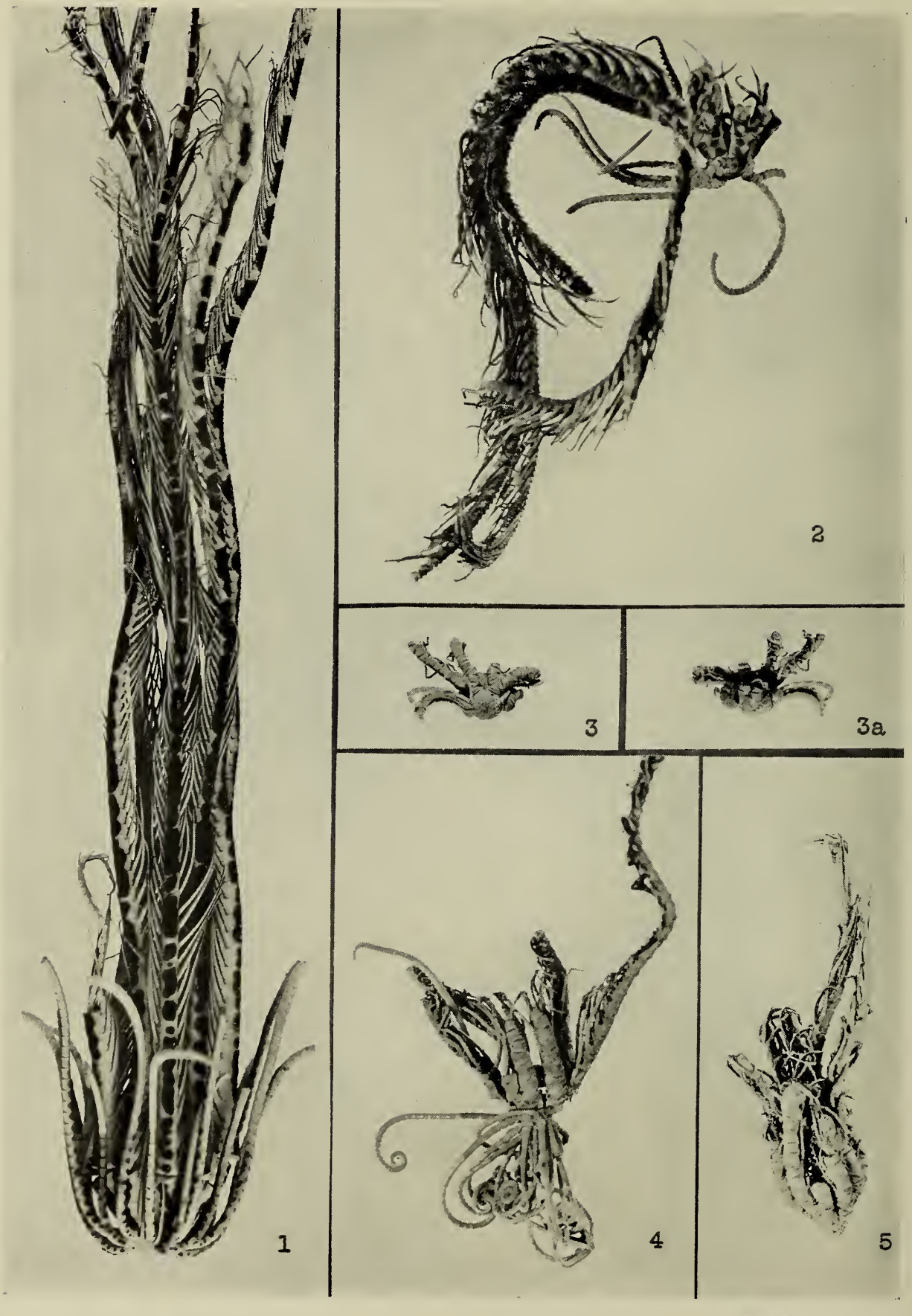

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DESCRIPTION OF PLATE I.

Fig. 1.—*Tropiometra magnifica* sp. nov., from Station 24, Gulf of Aden, 73–220 metres. Natural size.

Fig. 2.—*Colobometra arabica* sp. nov., from Station 10, Red Sea, 55 metres. × 2.

Figs. 3, 3*a*.—*Repometra arabica* gen. et sp. nov., from Station 53, South Arabian coast, 13·5 metres. × 3.

Fig. 4.—*Caryometra robusta* sp. nov., from Station 157, Maldive area, 229 metres. × 3.

Fig. 5.—*Fariometra sewelli* sp. nov., from Station 143, Maldive area, 797 metres. × 2.

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TO MAY 1937 PRESENTED

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JOHN MURRAY EXPEDITION

1933–34

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VOLUME IV. No. 5

THE PENNATULACEA

BY

SYDNEY J. HICKSON, F.R.S.

WITH TWO TEXT-FIGURES

B. M. (N.H.)

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INTRODUCTION.

The collection of Pennatulacea made by the Murray Expedition does not include any new species. All of them, with one exception (*Pteroeides* sp. ?), belong to species which have previously been described and well illustrated; but it is, nevertheless, a collection of considerable interest and importance. Some species, of which only a single or less than half a dozen specimens have been previously recorded, are represented by a large number of specimens, providing material for the study of growth and variation, and in one case (*Umbellula huxleyi*) proving that several previously described species are only growth stages or varieties of one widely distributed species. Some interesting facts concerning the geographical distribution of the deep-sea Pennatulacea are also revealed. For example, the very rare and remarkable species *Chunella gracillima* was found to exist in great numbers in the Pemba Channel, where it was first discovered by the "Valdivia" expedition. It was associated in both collections with *Funiculina quadrangularis*. The only other locality in which *Chunella gracillima* has been found is in the Bali Sea of the Malay Archipelago. Here also it was associated with the only specimen of *Funiculina* obtained during the voyage of the "Siboga".

If, as there is now good reason to believe, several species of *Umbellula* from the Indian Ocean, described by previous authors as new to science, are only growth stages or varieties of *U. huxleyi* (Köll.), this species, like many others from the deep sea, has a very wide geographical distribution, extending perhaps as far East in the Pacific Ocean as Hawaii, where a very similar form called *U. jordani* is said to occur (Nutting, 1908, p. 564).

The very large number of specimens of *Cavernularia orientalis* from one locality enabled me to confirm the wide range of variation that I found in a smaller collection of the same species from Amboyna (1916, p. 55), and to compare them with *Cavernularia darwinii* from the Pacific coast and neighbouring islands, which seems to be closely related to it.

Our knowledge of the sexual periodicity of both deep- and shallow-sea Pennatulacea is far too incomplete to enable us to form any definite conclusions on the subject, but the sexual condition of all the species has been noted. If the spawning time is annual and constant, then *Chunella* becomes ripe in January, *Umbellula huxleyi* in May and *Pennatula*

inflata probably in April. The gonads of *Protoptilium* indicate a spawning time about March. No gonads were observed in *Cavernularia* at the beginning of December, nor in *Scytalium* in March.

I wish to express my thanks to Col. Sewell for valuable advice and assistance, and to Prof. J. Stanley Gardiner for allowing me full facilities to work in the Department of Zoology in Cambridge.

August, 1936.

Cavernularia orientalis Th. and S.

1909. *C. orientalis*, Thomson and Simpson, " Investigator " Reports, Pt. II, p. 175.
1911. *Cavernulina cylindrica*, Kükenthal and Broch, " Valdivia " Reports. Pennatulacea, p. 175.

Occurrence.—Station 80, off the coast of Oman, near Muscat, 16 to 22 metres, Nov. 30, 1933 ; about 220 specimens of this species.

Descriptive Notes.—The examples ranged in total length from 16–80 mm. They have the usual club shape of Cavernularias preserved in spirit, the diameter gradually decreasing from near the top of the rachis to the end of the stalk. There is no marked constriction between rachis and stalk.

In a specimen 50 mm. in length the thickest part of the rachis is 10 mm. and the middle part of the stalk 5 mm. in diameter. These measurements represent only those of contracted preserved specimens and are of little scientific value, as we have no knowledge in this case of the diameters of the species when fully expanded (see p. 115, *C. malabarica*).

One of the characters that is frequently used for the determination of the species of Pennatulacea is the ratio of length of rachis to the length of stalk. The large number of specimens in the collection enabled me to test the validity of the character in this species, and I made the following measurements in millimetres :

T.		R.		S.		T.		R.		S.
18	=	6	+	12	.	60	=	35	+	25
22	=	8	+	14	.	60	=	32	+	28
35	=	10	+	25	.	80	=	45	+	35
65	=	28	+	37	.	80	=	50	+	30

Where T. = total length, R. = length of rachis, and S. = length of stalk.

These figures show that the ratio is very variable in this species and of no value for systematic purposes. The only result obtained is that in the small examples the stalk is longer than the rachis and that in the larger ones the rachis is longer than the stalk.

The boundary line between rachis and stalk is sometimes irregular and often difficult to determine, but there is never any projection upwards of the stalk into the rachis indicating an incipient bilaterality such as is found in *Echinoptilum*. The colonies are therefore quite radially symmetrical.

The autozooids are irregularly scattered all round the rachis, and each one is surrounded at the base by a small area free from spicules. There is no trace of a shelf or other form of verruca (calyx) as in the S. African genus *Actinoptilum*.

A few anthocodiæ were found fully expanded. The length of the body is 2·5 mm. and of the tentacles 1·5 mm. Each tentacle bears about nine pinnæ each side. There are no spicules in any part of the anthocodiæ.

The siphonozooids are also scattered. There is no arrangement of them on definite lines as in some other species of the genus.

The axis was present in all the specimens examined, but in no case extended through the whole length of the colony. In a specimen 80 mm. in length it was 25 mm. in length, one-third of it in the rachis and the rest in the stalk. In another, 22 mm. in length, it was 8 mm., of which only 1 mm. was in the rachis.

In both cases the extremities of the axis were very powdery in texture, and probably a short length of unintegrated axis was lost in the dissection.

The intact part of the axis is in section square, with rounded edges, and the greatest diameter of the larger ones is a little over 1 mm.

As several species of the genus have been described on the examination of one or only a few specimens, and as the presence or absence of an axis was one of the characters on which such species have been founded, it was clearly important to determine if this character is constant or variable. In the dissection of six other specimens of various sizes I found the axis square in section, occupying the same position relative to the rachis and stalk, and by probing twenty other specimens with a needle I found full confirmation of this presence and position of the axis.

The conclusion is that, in this species, the presence and relative length of the axis is constant. But Balss (1910, p. 83) found that in specimens from the same locality of *Cavernularia harbereri* an axis is present in some, but not in others.

This point is of some theoretical importance, because if the axis in these radially symmetrical forms is found to be variable, it may be taken as a sign that it is degenerating, but if it is fairly constant in size in each species, there is no reason to assume that it is what is often called a " rudimentary " structure.

I have already given (Hickson, 1918, p. 131) my reasons for believing that these radially symmetrical families are the most primitive of the Pennatulacea, and that in them we find, not the degeneration, but the evolution of the axis.

Spicules.—The most characteristic feature of this species is the shape of the spicules of the rachis. Instead of the usual straight needles of most of the species of the genus, many of them are branched or knobbed at one or both extremities. Some of them have an outline not unlike that of a flattened metatarsal bone with two or three rounded epiphysis-like processes at both ends ; in others these processes are triangular and pointed at the end (Text-fig. 1). A few spicules may be found which are shorter and thicker, corresponding with the type which A. Thomson called " capstans ".

The longest of these in a specimen 80 mm. in length is about 0·3 mm., but they are very variable in size. These are the characteristic spicules, but in addition there are numerous other, but mainly smaller, spicules which are smooth spindles, rods and other indeterminate shapes.

In a specimen 50 mm. in length there were not so many of the characteristic spicules in the rachis, and the largest of them were only 2 mm. in length (Text-fig. 1). In the smallest specimen examined, 22 mm. in length, these spicules were very scarce and had a maximum length of only 0·15 mm. (Text-fig. 1).

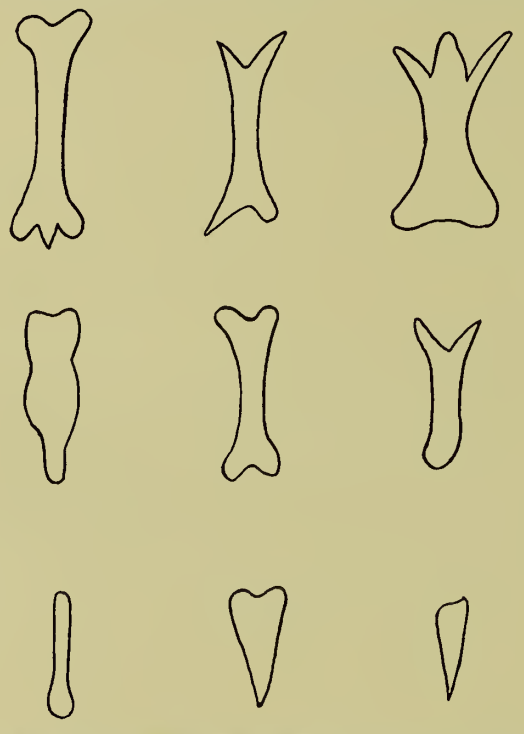
When preparations of spicules from specimens of different sizes are examined a great

range of variation may be observed both in size and shape, but it is obvious that they increase in size with the growth of the colony, and that the characteristic shapes of most of them are only attained in the full-grown colonies.

But when preparations of specimens of the same size (viz. 80 mm.) are examined a considerable but not so wide a variation in the spicules of the rachis may also be found.

It may be noticed that when I examined four specimens of the same species from Amboyna (1916, p. 53, text-fig. 9), a similar wide range in the variation of the spicules of the rachis was recorded.

The spicules of the stalk are confined to a layer at the surface about 0·3 mm. in thickness where they are densely packed together. Below this layer there is a spongy



Text-fig. 1.—Spicules of the rachis of *Cavernularia orientalis*. Top row of a specimen 80 mm. in length; middle row of a specimen 50 mm. in length; bottom row of a specimen 22 mm. in length. All × 66 diam.

tissue, 0·3 mm. in thickness, and below that again muscle bands, 0·6–0·8 mm. thick. No spicules of any kind were found below the surface.

When separated and mounted these spicules are bean- or pod-shaped, and in the largest specimens about 0·2 mm. in size (Text-fig. 2). In the smaller specimens they are of approximately the same shapes but not so large. No bone-shaped or bifurcated spicules were found in the stalk.

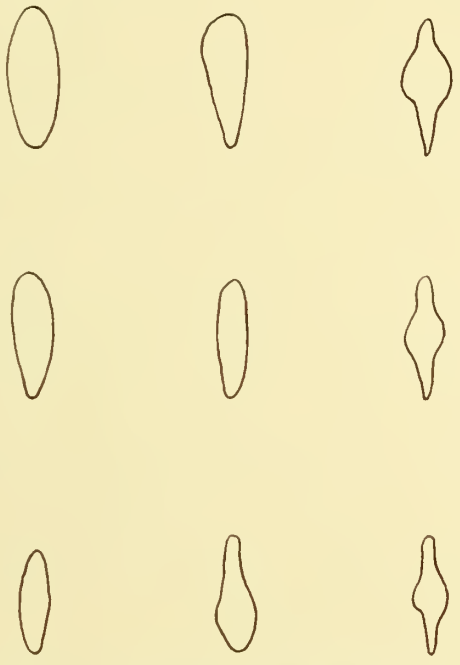
Colour.—A very noticeable feature of most of the specimens of the species in this collection is the pale amethyst colour of the rachis. The only reference I can find to the presence of a colour of this kind in a species of *Cavernularia* is that by Thomson and Simpson (1909, p. 306), in which they say that in two specimens of *C. lütkeni* from the Orissa coast the colour was "purplish".

Gonads: No gonads were seen by a lens in any specimen. November–December is therefore not the spawning-time of this species.

The type of this species was described by Thomson and Simpson (1909, p. 305). It was found off the coast of Orissa, but the depth was not given in the text. In size, characters of the spicules, the length and relations of the axis, it agrees very closely with some of the specimens in the "Murray" collection.

Two years later Kükenthal and Broch described a specimen from Amboyna in the Vienna Museum, for which they constituted a new genus *Cavernulina* and called it *C. cylindrica*. They expressed the opinion that it was closely related to Thomson and Simpson's *Cavernularia orientalis*.

In 1916 (p. 52) I described four specimens from Amboyna which I referred to Thomson and Simpson's species, and gave reasons for not accepting the new generic name



Text-fig. 2.—Spicules of the stalk. Top row of a specimen 80 mm. in length; middle row of a specimen 50 mm. in length; bottom row of a specimen 22 mm. in length. All × 66 diam.

Cavernulina, nor the distinction between Kükenthal's type and *Cavernularia orientalis*. The discovery of *Cavernularia darwinii* in the Galapagos Islands gives another point of interest to this species.

Note on *Cavernularia darwinii*.

A single specimen of a *Cavernularia* was found by Charles Darwin in the Galapagos Islands in 1835, but it was not examined or described until 1921 (Hickson, 1921, p. 372). At that time it was the only specimen of the family Veretillidæ known to occur on the Eastern side of the Pacific Ocean. Quite recently, however, Miss Deichmann (1936, p. 4) has described a species under the name *Veretillum binghami* from the Gulf of Lower California which cannot be separated from the Galapagos species, and by her kindness, and that of Dr. Schmitt of the Smithsonian Institution, I have been able to examine a specimen of the same species obtained by the "Albatross" Expedition from the coast of Ecuador. There can be no doubt that the Galapagos specimen and the specimens from the tropical Pacific coast of America all belong to the same species.

Cavernularia darwinii should be regarded as a distinct species from *C. orientalis*, but the resemblances between them are so remarkable that they are deserving of special consideration.

In both species there are present in the rachis bone-shaped spicules, an incomplete axis supports the colony, the spicules of the stalk are confined to a layer at the surface and there are no spicules in the anthocodiæ. As regards the relation of stalk to rachis the following figures are of some interest.

	T.		R.		S.
*C. *darwinii* (Galapagos) . .	90	=	55	+	35
C. *darwinii* (Ecuador) . .	95	=	60	+	35
C. *orientalis*	80	=	45	+	35
,, ...	80	=	50	+	30

Where T. = total length, R. = length of rachis, and S. = length of stalk.
Measurements in millimetres.

It will be noticed that the total length of the only specimens of *C. darwinii* I have measured is greater than that of any of the specimens of *C. orientalis* in the "Murray" collection, and the rachis is relatively a little bit longer. Miss Deichmann's type-specimen was much larger, being 250 mm. in total length, and the stalk is said to be "$\frac{1}{4}$ to $\frac{1}{3}$ of the entire length of the colony" in the three specimens she examined.

The relatively greater length of the rachis in these large specimens is what might be expected from the figures given above on p. 110. But, notwithstanding these resemblances between the two species, a comparison of preparations of spicules of the rachis shows that they can be readily distinguished, the most noticeable difference being that the characteristic spicules of *C. orientalis* are nearly twice as long as those of *C. darwinii*. In the largest specimens of *C. orientalis* they attain to a length of 0·3 mm.; in the still larger specimens of *C. darwinii* they are only 0·15 mm. in length. For this reason the two species may be considered to be distinct.

The opportunity here afforded may be taken to announce that the type-specimens of *C. darwinii* and of *Gorgonia darwinii* collected by Charles Darwin in the Galapagos Islands, together with my preparations made from them, have now been transferred to the British Museum.

Note on Another Species of *Cavernularia*.

Most of the species of *Cavernularia* are inhabitants of shallow coastal waters, and it is probable that, in normal life, they are lightly attached by their stalk to a sandy or muddy bottom. There are only two records of specimens of this genus being washed ashore, one on the coast of Orissa, and the other on the coast of Borneo (Hickson, 1921, pp. 370 and 373). The former were referred to the species *C. malabarica*, Fowler, and the latter to *C. chuni*, Kükenthal and Broch. The specimens collected by Dr. Hose after a storm at Miri, in Borneo, are all tightly contracted, but they agree very closely with the description of the type of *C. chuni* (Kükenthal & Broch, 1911, p. 190).

The type-specimen of Fowler's (1894, p. 376) *C. malabarica* and the specimens collected by Dr. Imms on the Orissa coast are fully expanded.

* By an oversight in correcting the proof of the original description of *C. darwinii* the figures given for the lengths of rachis and stalk were not correct. The figures given here are of a re-measurement of the type-specimen.

The diameter of the rachis of the Borneo specimens is only slightly greater than that of the stalk, but the diameter of the rachis of the Orissa coast specimens is at least twice that of the stalk.

Apart from this character the specimens are in close agreement, and after further investigation I have come to the conclusion that *C. chuni* is identical with *C. malabarica*.

The diameter of the rachis is a character which depends entirely on the degree of contraction of the specimen when preserved and is of no systematic importance.

The special points of interest that all these specimens have in common are the remarkably short stalk and absence of an axis. They seem to indicate that their power of attachment to a muddy or sandy sea bottom must be much less than that of other species with a long stalk and an axis with its strong muscular attachments. The absence of an axis and its muscles makes them lighter than other species, and it seems probable therefore that their usual habit is to float or drift about in the sea like a *Pelagohydra*, and therefore are washed ashore sometimes after a storm.

The consideration of these specimens confirms the view that I ventured to put forward in 1918 (p. 131) that in these radially symmetrical Veretillidæ we have the most primitive forms of the Pennatulacea.

Funiculina quadrangularis Pallas.

Pennatula quadrangularis Pallas, Elench., 1766, p. 372.
Kükenthal and Broch, " Valdivia " Reports, p. 243.

Occurrence.—Stations 108 and 122, in the Pemba Channel, 786 and 732 metres respectively ; several specimens of a Pennatulid, which could be identified as a species of *Funiculina*. They were associated with specimens of *Chunella gracillima*.

Descriptive Notes.—The examples were in such a bad state of preservation that only small patches of a soft black fleshy substance remained attached to the axis. When washed and cleared in oil these fragments showed the characteristic spicules of the genus and some characters of the autozooids top rove that they belong to the genus *Funiculina*. It seems very probable that the deplorable state of these specimens was not due to the process of preservation in spirit, but to a moribund and partly macerated condition when captured.

It is quite impossible to determine the species of *Funiculina* to which they belong, but there are some reasons for referring them to the old and widespread species *F. quadrangularis* of Pallas. The " Valdivia " expedition obtained about 200 specimens of a *Funiculina* from the same station in the Pemba Channel as that from which *Chunella gracillima* was found, and Kükenthal and Broch (1911, p. 243) were able to give accurate measurements of 88 of these and write a full account of the anatomy of the species.

There can be no doubt that the " Valdivia " specimens were much better preserved than those obtained by the " Murray " expedition, and, therefore, their reference by the authors of the report to *Funiculina quadrangularis* must be accepted.

The most interesting feature about them is that they confirm the association of *Chunella* and *Funiculina* in the Pemba Channel, previously discovered by the " Valdivia " expedition. As an example of an association of two genera in a restricted locality it is not by itself very remarkable ; but in the Malay Archipelago the only specimen of *Funiculina* found in the very extensive " Siboga " collection came from the same station as the specimens of *Chunella gracillima*. But *Funiculina* has been found in the Indian Ocean elsewhere than associated with *Chunella*. Thomson and Henderson (1906A, p. 110)

described one specimen of *F. quadrangularis* and several specimens of a new species which they named *F. gracilis* from deep water in the Bay of Bengal, and there is one specimen in the " Murray " Expedition collection from Station 143 in the Maldive Archipelago.

No general description of these specimens can be given. In the collection there were very many bare axes which might have belonged either to the *Chunella* or the *Funiculina*. Fragments of *Funiculina* flesh were found on only a few of them, but it is worth noting that one of these was nearly 1 meter in length. The longest specimen of this species in the " Valdivia " collection was only 693 mm. in length.

Protoptilum cyaneum Kükenthal.

P. cyaneum, Kükenthal and Broch, " Valdivia " Reports, 1911, xiii, heft 2, p. 257 (70 specimens).

Occurrence.—Station 16, off Berbera in N. Somaliland, 186 metres.

Descriptive Notes.—The type of this species was the only specimen obtained by the " Valdivia " Expedition. It was found in 1242 metres of water off the coast of Somaliland. Although the type came from much deeper water than the specimens in this collection, there can be no doubt that they all belong to the same species.

The autozooids of some of the specimens have the pale blue colour which gave the species its specific name " *cyaneum* ", but in the majority there is no blue colour, the whole colony being pale-cream or colourless. I am informed by Col. Sewell that the colour of these Pennatulids when captured was a " reddish tint " which dissolved in spirit.

The type-specimen, which was only 114 mm. in total length, was probably a young or juvenile form.

The largest specimen in the " Murray " collection was 430 mm., the smallest 240 mm. in length. The average length of all the specimens cannot be given as so many of them were imperfect, but the majority were certainly over 300 mm. in length. It is unfortunate that no small or very small specimens were found, as very little is known about the growth stages of the species of this genus, and such specimens might have thrown some light on the true systematic position of several species which have been given separate generic names (see Hickson, 1916, p. 96).

In the original definition of the species the stalk was said to be one-third of the total length. This ratio, however, was found to be much more variable than was expected. In the largest specimen, 430 mm., the stalk was 200 mm. in length ; in the smallest, 240 mm., the stalk was 60 mm. in length, and in four specimens, ranging from 280–380 mm. in total length, the stalk was approximately a third of the whole length. The ratio varies therefore from 2 : 1 to 4 : 1, and apparently the relative length of the stalk increases with the increase in the total length.

The autozooids are protected by a well-developed calyx terminating in six projecting tooth-like groups of spicules. These processes are so frequently broken in the actual specimens that it is difficult to determine whether the number six is absolutely constant. The total length of the calices is approximately 4·5 mm. They are distributed unevenly on the ventral and lateral sides of the rachis. In some specimens they are arranged on some parts of the rachis in oblique rows of three, in others there is a rough arrangement in two or three longitudinal rows, but taking the specimens as a whole there is not any very constant arrangement of the autozooids.

The siphonozooids are very numerous. There is a dense longitudinal row of them

on each side of the dorsal track and many others between the autozooids. They can be seen as low verruciform projections from the surface about 0·15 mm. in diameter in some specimens, but in others they are almost completely hidden.

In the description of the type-specimen Kükenthal and Broch give as a distinguishing feature of the species the character that the siphonozooids are scarce (sehr spärlich). At first sight this might be thought to be the case with some of the "Murray" specimens, as these zooids can hardly be seen even with a simple magnifying glass. When, however, slices of the rachis are decalcified and stained, the siphonozooids are found to be quite as numerous in these specimens as in those with visible verrucæ.

The most important character of the siphonozooids is that, as in the type-specimen, they are not supported by a definite calyx of spicules. The consequence is that in some forms of contraction they are completely covered and hidden by the dense layer of spicules of the surface of the cœnenchym.

The long slender stalk is completely cylindrical in shape and terminates below in a well-marked bulbous expansion. In these preserved specimens there is considerable variation in the size of this bulb, but in specimens 300–400 mm. in length it is about 10 mm. long by 4 mm. in diameter. The axis is cylindrical throughout its whole length, the greatest diameter being about 0·75 mm. The spicules are of the usual 3-flanged type and reach a maximum length of about 1 mm.

Gonads: Several specimens were examined, but only in two of them were gonads observed. One was a female with ova less than 0·1 mm. in diameter, and the other was a male with testes of about the same size. It is certain that they were not nearly ripe, but it is impossible to form a definite opinion as to the time of year when they might be expected to spawn. They were captured on October 21st, and, if we may judge from our knowledge of some other Alcyonaria, it is unlikely they would spawn before the end of the year, but more probably not until March of the following year.

The *Protoptilum cyaneum* of the coast of Somaliland is the only species of the genus that has been found in the Indian Ocean. Three species are known from the Atlantic Ocean, one from the Malay Archipelago, one from Hawaii and one from Japan. The only one of these that is allied to *P. cyaneum* is *P. denticulatum*. This species was described from a single specimen found at the great depth of 1695 fathoms in the Atlantic Ocean 58° 20′ N., 40° 48′ W. (Jungersen, 1904, p. 89). It had a total length of only 75 mm., and may be, therefore, only a young stage in the growth of a much larger specimen. However, even in this young stage, the siphonozooids possess a well-defined calyx provided with two teeth, and judging from Jungersen's description and figures they are numerous, but not so numerous as in *P. cyaneum*. There is, therefore, no reason to suppose that the Somaliland species is identical with *P. denticulatum* or any other species of the genus.

Chunella gracillima Kükenthal.

C. gracillima, Kükenthal and Broch, 1911, "Valdivia" Reports, p. 272.
C. gracillima, Hickson, 1916, "Siboga" Reports, p. 111.

Occurrence.—There were three tubes in the collection containing specimens of *Chunella* from Stations 108, 122 and 124, at depths of 786, 762 and 914 metres respectively, and two jars containing hundreds of pennatulid axes from Stations 108 and 122, which most probably are the axes of this *Chunella* and of *Funiculina*. All these stations were in the Pemba Channel.

Distribution.—It is interesting to note that it was from this locality that the " Valdivia " expedition obtained the original type-specimens which Kükenthal and Broch (1911, p. 272) described as *Chunella gracillima* and *C. quadriflora*.

Two specimens of the same species were found by the " Siboga " expedition (Hickson, 1916, p. 111) at a depth of 1018 metres in the Bali Sea in the Malay Archipelago. I can find no record of the occurrence of the species in any other locality.

Descriptive Notes.—I am informed by Col. Sewell that the autozooids of *Chunella* when captured were of an " indigo blue colour ", but this colour dissolved in the spirit.

In all the vessels there were found, in addition to the *Chunellas*, whole specimens or fragments of *Funiculina quadrangularis*, and in the tubes there were pieces of the glass-like rods of the sponge *Haliphysema*. From the first two tubes examined I was able to unravel thirteen unbroken specimens of *Chunella*. In the third tube the specimens were in such an elaborate tangle that it was impossible to form even a reliable estimate of the number present, or to measure any one of them. In the two jars there were numerous Pennatulid axes coiled up in bundles. On some of these there were fragments of the flesh of *Chunella*, on others of the flesh of *Funiculina*. At a rough estimate there were about 100 specimens of the two genera represented by whole specimens, bare axes or fragments. It is quite evident that at depths of 700–1000 metres in the Pemba Channel this rare deep-sea Pennatulid, accompanied by *Funiculina*, exists in great numbers.

Unfortunately none of the specimens were very well preserved. In the rough and tumble of coming up from a great depth in a dredge and then being packed away in tubes a good deal shorter than their total length many of them were broken, and the soft flesh covering the axis rubbed off in places, or wholly. All this was doubtless quite unavoidable but the collection is nevertheless of considerable scientific interest.

These long and very slender sea-pens bear at variable intervals of 50–60 mm. apart whorls of three autozooids. Up to the present time the total length has been measured and the number of whorls recorded of four specimens, two from the Pemba Channel by Kükenthal and two from the Bali Sea by myself. The total length of the thirteen specimens of the " Murray " collection that were measured varied in total length from 300–670 mm. Among these, one, 590 mm. in length, had six whorls ; two, each 470 mm. in length, had five whorls ; four, measuring 300–400 mm. in length, had three or four whorls.

In this statement the number of whorls actually preserved is given. It is possible that in some cases one or more whorls have been lost. In a specimen, for example, 670 mm. in length there were only four whorls preserved and probably two or three have been lost. Comparing these results with those of previous descriptions of the species we find a general agreement. Kükenthal's two specimens were 580 and 365 mm. in length and had five and four whorls respectively. The specimen 755 mm. in length collected by the " Siboga " expedition had nine whorls, but the smaller one 365 mm. in length had five whorls. Thus, roughly speaking, and leaving room for some variations, the progress of whorl development in the species may be represented by the following figures :

Total length in mm.	Number of whorls.
300–400	3–4
400–500	4–5
500–600	5–6
700+	9

The third, fourth and fifth whorls from the free end of the colony bear three autozooids; the first and more rarely the second bear only two autozooids, although a rudimentary third may be visible.

Kükenthal (1911, p. 275) described a specimen which he called *C. quadriflora*, from the same locality in the Pemba Channel as that of *C. gracillima*, in which the second and third whorls bore four autozooids.

I have examined a great number of the whorls of the " Murray " specimens and have not found a single one with more than three autozooids. The existence of *C. quadriflora* in the Pemba Channel cannot, therefore, be confirmed.

The axis of all the specimens is, as previously described, quadrangular, with very rounded angles, becoming cylindrical below and drawn out to a very fine thread at the distal ends. The greater diameter of the axis in the lower end of the stalk of a specimen about 400 mm. in length was 0·9 mm., and of the terminal thread about 0·28 mm. The axes of the *Funiculina* from the same dredging are also quadrangular and drawn out to an exceedingly fine thread at the distal ends.

It is very remarkable that in two genera of Pennatulids so far apart systematically as *Chunella* and *Funiculina* the axes should be so much alike that in external characters they are indistinguishable. There may be differences in histological detail which I have not discovered, but pieces of the axis of the two forms exposed to an acid for several days revealed no noticeable differences.

The material was not sufficiently well preserved for making satisfactory preparations to illustrate the finer details of the structure of the soft parts, but I have found no reason to doubt the accuracy of previous descriptions of the autozooids and of the distribution of the siphonozooids.

Gonads : All the autozooids of the larger specimens were packed full of gonads, which from the appearance of the nucleus of the ova seemed to be nearly ripe. The largest gonads were over 1 mm. in diameter. All the specimens were collected in the month of January.

Umbellula huxleyi Kölliker.

U. huxleyi, Kölliker, 1880, " Challenger " Reports, Zool., I, p. 21.

Occurrence.—(i) Station 194, off Aden, 220 metres ; about 240 specimens of a species of *Umbellula* were obtained. (ii) Station 185, off S. coast of Arabia, not far from Aden, 2001 metres ; one specimen of the same species. (iii) Station 143, Maldive Archipelago, 797 metres ; three specimens.

Descriptive Notes.—A detailed examination of all these specimens has not been made, but the principal characters of six selected examples have been determined, and certain special features of many other specimens have been noted. There can be no doubt that they all belong to the same species, but it has not been an easy task to determine which of the many species of similar Umbellulas in the literature of the subject they should be referred to. This problem is discussed below.

The largest specimen is 300 mm. and the shortest 130 mm. in total length.

The number of autozooids in the terminal tassel is very variable, but, roughly speaking, the number increases with the increase in length and in age (?). The exact number cannot be determined by a superficial examination with a lens. The only accurate method is to

cut off the autozooids one by one and count them as they fall; but as this is a very destructive method, I have used it only on a few specimens. The results were as follows: A specimen 250 mm. in length bore 28 autozooids, a specimen about 200 mm. bore 22 autozooids, and the smallest I could find, 130 mm. in length, bore only 6 autozooids.

The size of the autozooids in the preserved specimens is even more variable; the length of the body, apart from the tentacles, may be 20 mm. in big specimens, and only 4 mm. in small ones, but there is a wide range in length according to their degree of contraction. As the specimens were dredged and preserved at the same time it might have been expected that the contraction would be the same in all cases; but there is another factor which influences the length of the autozooids. In most of the specimens the body cavities of the autozooids and even the cavities in the tentacles are packed with gonads; in others there are no gonads. The autozooids in the former case are long and comparatively slender and the tentacles are usually fully extended; the autozooids in the latter are short and sometimes globular in shape, and the tentacles are either very short or broken off and lost.

This gives the autozooids of the pregnant and the shotten specimens a very different appearance, and it is obvious that the pregnancy offers a physical impediment to contraction.

It is usually quite easy to recognize without dissection the ripe from the barren autozooids, as in the former the gonads are clearly indicated by rectangular areas on the surface of the body-wall. Such markings are clearly shown in Kölliker's figure (1880, pl. ix, fig. 37*a*) of *Umbellula huxleyi*, and in Kükenthal and Broch's picture (1911, pl. xvi, fig. 17) of *U. spicata*. In the picture of *U. pellucida* (pl. xvi, fig. 20) by the authors of the '"Valdivia" Reports' the autozooids are strongly contracted, and there are no quadrangular markings on the body-wall. Moreover the specific name "pellucida" could not have been reasonably applied to polyps pregnant with gonads. No mention is made in the "Valdivia" report of the sexual condition of any of the species, but there can be little doubt that the two species *U. spicata* and *U. pellucida* are only pregnant and barren forms of the same species. Both species were dredged off the coast of Somaliland, and I can find no reason to separate them from the species collected by the "Murray" expedition, which I have identified as *U. huxleyi*.

Gonads: The gonads of several specimens were examined. The largest measured were about 0·8 mm. in diameter, as preserved, and judging from their histological condition they were very nearly mature in both sexes. All the autozooids of a specimen were either male or female. There was no case of hermaphroditism or of viviparity. The specimens were collected on May 2nd, 1934.

Exact information concerning the time of spawning and its duration and of the manner of discharge of the gonads is lacking and may never be obtained, owing to the great depth in which these animals live, but as the specimens were collected in the month of May it seems probable that they are discharged late in May or early in June.

The extraordinary fecundity of the polyps and the very large size of the ripe ova make it difficult to believe that they are discharged one by one by the mouth. There may be another method of discharge, and it may be suggested that this is afforded by the detachment of the tentacles. If so it accounts for the absence of the tentacles from so many of the shotten autozooids.

In many of the descriptions of the species of *Umbellula* diagrams are given showing the arrangement of the autozooids on the rachis. In some species the arrangement is said to be bilateral, and in others in concentric circles. In the diagrams of five specimens of *Umbellula pellucida* given by Kükenthal and Broch (1911, pp. 301 and 302) the arrangement is quite irregular, but in the diagnosis of the species it is described as " in annähernd koncentrischen Kreisen ". Moreover, it may be observed the arrangement is not the same in any two of the five specimens attributed to this species.

I examined this character in four specimens. In one it was roughly bilateral, in another the autozooids were arranged in irregular concentric circles, and in the other two there seemed to be no definite arrangement. It seems consequently that this character is so variable as to be of no systematic value.

I have made no attempt to give a complete record of the distribution of the siphonozooids, as the specimens are not sufficiently well preserved to provide reliable results.

In former papers (1907, p. 13, and 1916, p. 117) I have discussed the value of siphonozooids for systematic purposes. The discovery of siphonozooids on the stalk, even as far down as the bulb at the base, many of which are quite invisible from a surface view, requires, for a complete record of their distribution, not only very well preserved material, but series of stained sections from regions through the whole length of a specimen. Without these conditions results may be very misleading.

The presence of a single tentacle on these zooids is very difficult to deny for any specimen, dredged up from such depths and roughly preserved, as they are very easily detached and lost. All that can be said definitely about the specimens of the " Murray " expedition is that the siphonozooids of the rachis have a stomodæum about 0·14 mm. in length and support one pair of long mesenteric filaments. Tentacles were not observed on any of them.

The axis in all the specimens is quadrangular in section ; that is to say, it is marked by four shallow longitudinal grooves with four prominent rounded ridges. At the stalk end the ridges become shallower, and for a considerable distance the axis becomes almost circular in section. The greatest width of the axis of a large specimen is 1 mm.

There are no spicules in the autozooids nor in any part of the rachis.

The Problem of the Species.

In the whole literature of the Alcyonaria there is no worse example of the unnecessary multiplication of species than is found in the history of this genus.

In the early days specimens of *Umbellula* were rarities, and systematists gave a new specific name, often quite justifiably, to every new specimen that was found. But with the increase in our knowledge of the fauna of the deep seas the number of specimens available for examination rapidly multiplied and the unfortunate habit continued. The result of this has been that some forty species of *Umbellula* have been described, of which probably less than one-half will prove to be valid.

We have a good example of this in the Umbellulas of the Indian Ocean. No less than 11 species have been described from this region which agree in having comparatively small autozooids, which bear no spicules, in having a long, very slender stalk with a small terminal bulb and a square axis.

In the description of these species no consideration has been paid to the possibilities of variation, to the effect of changes due to rough capture or preservation, or to the sexual

condition. There is also no clear indication given of the essential characters of the species or of their relations to one another.

Of the 11 species, five were described from 1 specimen each, 1 from 2, two from 3, one from 4, and one from 8 specimens. In the description of one species the number of specimens was not recorded. It is obvious that in most of these cases the study of variation was not possible. As all these species inhabit considerable depths of water (100–1000 fathoms), it is inevitable that there must be considerable changes in their appearance before they come on deck, to say nothing of subsequent changes due to imperfect preservation. Single specimens obtained in a haul of the net, if not injured by mud, stones and other objects in their passage from the bottom, are often well preserved, but if a net comes up packed with booty of various kinds specimens of *Umbellula* are often seriously damaged. The result of this is that specimens which really belong to the same species may, when examined in the laboratory, have such a different appearance that, unless they are critically considered, they may be regarded as representatives of distinct species.

That there is only one species in this large collection made by the "Murray" expedition is a view which for many reasons must be accepted.

It is very improbable that a large number of specimens belonging to the same genus, and all in approximately the same sexual condition, living in the same locality in deep water, should belong to more than one species. Any cross-fertilization that might occur would soon swamp any specific distinctions.

A careful examination of the whole collection revealed no discontinuity. From the largest to the smallest there was a continuous series without any well-marked break.

On the Probable Synonyms of *U. huxleyi*.

Four of the species collected by the "Valdivia" expedition, *U. spicata*, *U. valdiviæ*, *U. köllikeri* and *U. pellucida*, came from the coast of Somaliland, or of equatorial E. Africa; one, *U. rigida*, from the neighbourhood of the Chagos Archipelago.

Five species, *U. purpurea*, *U. elongata*, *U. radiata*, *U. pendula* and *U. indica*, with similar general characters, were collected by the "Investigator" from other localities in the eastern part of the Indian Ocean at depths of 290–1803 fathoms. The type-specimen of *U. huxleyi* was found by the "Challenger" expedition at 565 fathoms off Yeddo, Japan, but Kükenthal and Broch (1911, p. 290) described a specimen from Great Nicobar which they identified as *U. huxleyi*. Two species, which I identified (1916, pp. 133, 134) as *U. jordani* and *U. pellucida* respectively, came from great depths in the Malay Archipelago.

All these species have one striking character in common—the absence of spicules in the autozooid and rachis. They have autozooids which are small as compared with those of some other species of the genus, and most of them (perhaps all) have a square axis.

The study of the numerous specimens in the "Murray" collection, and the comparison of selected specimens with the figures and descriptions of the species named above, has led definitely to the conclusion that they all represent stages of growth or of sexual condition or of post-mortem stages of one species, which by the law of priority should be called *U. huxleyi* (Kölliker, 1880).

If this view is correct, the species presents us with another example of the widespread distribution of the deep-sea Alcyonaria. If it is not, it would afford a quite exceptional case of several closely related species living in the same deep-sea area.

Pennatula inflata Kükenthal.

Pennatula inflata, Kükenthal and Broch, 1911, p. 350.

Occurrence.—Station 145, Maldive Archipelago, 510 metres; two specimens of a *Pennatula* belonging to the "grandis" group of species.

Descriptive Notes.—These are large fleshy sea-pens with numerous large lanceolate leaves, with pads or stripes of siphonozooids on the dorsal side of the rachis, leaving a broad bare track between them. A very characteristic feature of these species is the presence of a very thick swelling at the junction of the rachis and stalk, due to the presence in the subjacent tissues of a powerful sphincter muscle. They are all inhabitants of deep or very deep water.

Several specific names have been given to specimens belonging to this group from N. Atlantic waters (*e. g. P. grandis*, *P. borealis*, *P. bellissima*), but it seems probable that these are only varieties of one species, which should be called *P. grandis* Ehrenberg.

In 1911 (p. 350) Kükenthal and Broch gave a full description of nine specimens of a Pennatulid found off the coast of Somaliland in 628–741 metres of water which they named *Pennatula inflata*.

The differences between *P. inflata* and typical examples of *P. grandis* are not very important and are quite overshadowed by their resemblances, but before we can reach the conclusion which future discoveries will probably reveal, that *P. inflata* is only a variety of the widespread species *P. grandis*, a more detailed knowledge of the variation of the North Atlantic species is necessary.

The two principal characters given by Kükenthal and Broch to distinguish *P. inflata* from the other species of the "grandis" group are:

1. That the groups of siphonozooids on the dorsal surface are usually not connected with one another.

2. That one of the eight terminal spines of the calyx of the autozooids is longer than the others.

The arrangement of the siphonozooids in the "Murray" specimens agrees with that given in the descriptions of the type. On the dorsal side of the rachis there are curved pads (Wülste) of siphonozooids grouped round the edge of the leaves. They are quite distinct from one another in the lower part, but become more or less continuous in the upper part of the rachis.

In *P. grandis* the dorsal stripes of siphonozooids are said to be continuous. It would be interesting to know if in any specimens these stripes are discontinuous as they are in *P. inflata*. But, in any case, this is not a character of great systematic importance.

When horizontal sections of these pads are examined it is seen that they bear two kinds of zooids. There are numerous typical siphonozooids with a diameter of about 0·3 mm., and a smaller number of much larger zooids with a diameter of about 0·9 mm. The latter, with their wide open stomodæum, eight complete mesenteries with muscles on some of them, inconspicuous siphonoglyph and no tentacles, agree with the type of zooids I described as Mesozooids in *Pennatula Murrayi* (1916, p. 194). This is probably not a point of difference but of resemblance between *P. inflata* and *P. grandis*, as in the latter species peculiar large zooids were long ago observed by Sars and Kölliker, and in later years were described as "Geburtsöffnungen" by Balss (1910, p. 53). Their function is

certainly not that of oviducts, but most probably that of safety valves to allow a rapid expulsion of water from the tissues in case of alarm (see Hickson, 1916, p. 194).

Judging from the little we know of the natural history of the sea-pens, it seems very probable that when disturbed by the dredge these fleshy species discharge a large quantity of water from the tissues, and when the specimens arrive at the surface and are preserved they are considerably deflated. The prominent swelling at the junction of the rachis and stalk may not be noticeable in the fully-inflated condition, but owing to the large sphincter muscle cannot contract to the same extent as the other tissues and becomes prominent. It is really the result of deflation, not of inflation. In the specimens described below there is also a single row of siphonozooids running between the leaves from the dorsal pads to the ventral edge of the leaves, as in the type of *P. inflata* and in *P. bellissima* (Fowler, 1888, p. 135).

As regards the second character, the autozooids composing the leaves are attached to one another at the base, but a considerable but very variable part of each of them is free. This free part is protected by a sheath of needle-shaped spicules, terminating in eight spinous groups. In our specimens, as in the type, one of these groups is usually decidedly longer than the others. But owing to the damaged state of many of the leaves it is difficult to say whether this is a constant character, and constitutes a real specific distinction of *P. inflata* from *P. grandis*.

There can be no doubt that the " Murray " specimens from the Maldives belong to the same species as the " Valdivia " specimens from the coast of Somaliland, and in my opinion they should be named *Pennatula inflata* for the present, leaving the question of the identity of *P. inflata* and *P. grandis* for further critical examination.

A brief description of the two specimens is necessary.

The total length of Specimen A is 325 mm. and of specimen B 320 mm. The largest of the nine " Valdivia " specimens was 244 mm. and the smallest 44 mm. in length.

The relative length of rachis to stalk is—

Specimen A : Rachis 270 + stalk 55 = 325 mm.
,, B : ,, 260 + ,, 60 = 320 ,,

In agreement with Jungersen I consider the boundary between the stalk and rachis to be the ridge-like edge of the sphincter swelling. Kükenthal and Broch seem to have taken the lowest leaf as marking this boundary. Bearing this in mind, the relative lengths of stalk and rachis do not afford a satisfactory distinction between *P. inflata* and *P. grandis*. The breadth of the rachis cannot be determined in these crumpled specimens with any degree of accuracy.

The number of leaves on each side of the two specimens is 35 or 36. In the largest " Valdivia " specimen the number was only 24 or 25.

One of the largest leaves in Specimen B was about 70 mm. in length along its outer border and bore about 25 autozooids.

The spicules seem to be quite identical with those of the type.

In a few partially-expanded autozooids no spicules were observed in the tentacles : in this respect the species differs from *Pennatula grandis* according to Kükenthal and Broch (1911, p. 350).

Colour.—The rachis of specimen A is red, of specimen B yellowish brown. In both specimens the stalk is colourless.

Gonads : Both specimens were female. The largest ova were about 0·9 mm. in

diameter. They were captured at the beginning of March, but, judging from the appearance of the germinal vesicles, they were not nearly ripe for spawning.

Scytalium splendens (Th. & H.).

Pennatula splendens, Thomson and Henderson, 1906, "Investigator" Reports, Pt. I, p. 116.

Occurrence.—Station 145, Maldive Archipelago, 510 metres. There is only one specimen of this genus in the collection, and this is probably identical with *Scytalium splendens* from the Andaman Islands, 55 fathoms.

Descriptive Notes.—The specimen was unfortunately very severely mutilated when captured and some characters cannot be determined.

It has a total length of approximately 350 mm., of which 310 mm. belong to the rachis and 40 mm. to the stalk. There is a well-marked swelling, 10 mm. in diameter, in the sphincter region between stalk and rachis.

The largest leaves have a length of 40 mm., and they are composed of thirty to forty autozooids arranged in a single or double row.

The spicules have the size and shape characteristic of the genus, *i. e.* they are oval or "biscuit-shaped"* corpuscles with a maximum diameter of 0·06 mm.

The colour of the rachis is dark red, of the stalk white speckled with red. The partially expanded autozooids are yellow.

Neither the exact number of the leaves nor the distribution of the siphonozooids could be determined in this mutilated specimen.

There were no gonads in this specimen dredged at the beginning of March.

There is no difficulty in distinguishing specimens belonging to the genus *Scytalium* from other Pennatulids. The spicules are quite peculiar to it, and cannot be mistaken for those of any other genus.

Unfortunately Kölliker (1872, p. 233) used the expression "Lange schlanke Seefedern vom Habitus der Virgularieen" in his original description of the genus. This phrase is applicable to the type of the species *S. sarsii*, which was nearly 500 mm. in length and bore numerous very small leaves only 2 mm. in length, but it is not so to the species *S. splendens*, of which the type-specimen was 340 mm. in length and bore leaves 23–25 mm. in length, nor to *S. veneris*, nor to *S. balssii*. These are not slender sea-pens, but have leaves which are comparatively large, and in form resemble species of *Pennatula* far more closely than any of the Virgularians.

As I have pointed out (1916, p. 179), not only in form but also in general anatomy *Scytalium* is more closely related to *Pennatula* than to *Virgularia*, and its proper place is in the family Pennatulidæ and not in the family Virgulariidæ.

There is exceptional difficulty in dividing the genus into well-defined, specific groups, as the spicules of all the specimens are almost identical.

Scytalium tentaculatum and *S. balssii* seem to differ from the others in the presence of a single digitiform process on the calyx of each autozooid. The species described by Thomson and Henderson (1906A, p. 115) under the name *Pennatula veneris* may be distinct on account of the peculiar whip-like development of the terminal autozooid and some other minor characters.

* The expression "biscuit-shaped" is applied to flat oval spicules with a constriction in the middle like an hour-glass.

The other species may be divided into two groups, *S. sarsii* and *S. martensii* with small leaves bearing only a few autozooids, and *S. splendens* with large leaves bearing numerous autozooids.

This character is admittedly not a very satisfactory one for distinguishing species from one another, as it is liable to considerable variation, but a comparison of the measurements of all the specimens that have been described does show a distinct discontinuity between the large-leaved and small-leaved species.

In his description of a specimen from Japan which he called, erroneously in my opinion, *Scytalium martensii*, Kükenthal (1911, p. 315) suggested that the larger leaves bearing more numerous autozooids in his specimens, as compared with other specimens of *S. martensii*, was a difference due to age (" Altersunterscheide ").

This view does not seem to be in agreement with facts which have since been discovered. In the " Siboga " collection, among 100 specimens of *Scytalium martensii*, I measured one with a total length of 600 mm. and leaves only 2 mm. in length bearing 10 autozooids. Kükenthal's specimen was only 420 mm. in length and had leaves 29 mm. in length bearing 60 autozooids.

Several other examples could be quoted of short-leaved forms having a greater length than the large-leaved forms. As we know nothing at present about the growth stages of any one species, these facts do not prove definitely that Kükenthal's view was wrong, but they do justify the retention of the character " large-leafed " to distinguish *Scytalium splendens* from *Scytalium martensii*, which is " small-leafed ".

Since the discovery of the type-specimen of *S. splendens* in the Andaman Islands, Balss (1910, p. 49) has recorded the occurrence of several specimens, which he correctly referred to this species, in Japanese waters. Some of these came from shallow water in Sagami Bay.

In the following table a comparison of the measurements of two short-leaved forms with those of three specimens of *S. splendens* may be made :

	Total length.	Length of leaves.	Number of autozooids.
S. martensii (" Siboga " Exp.) .	600 mm. .	2 mm. .	10
S. sarsii (" Siboga " Exp.) . .	525 + mm. .	2–5 mm. .	25
S. splendens (type) . . .	340 mm. .	25 mm. .	60
,, (Japan) . . .	600 ,, .	26 ,, .	50
,, (" Murray " Exp.) .	360 ,, .	40 ,, .	30–40

It will be seen from these figures that the " Murray " expedition specimen from the Maldives differs from the other two in having much longer leaves, bearing comparatively few autozooids, but it is in no way intermediate between the short-leafed and the long-leafed species.

Thomson and Simpson (1909, p. 283) described an interesting specimen from 60 fathoms in the Andaman Archipelago with a total length of 285 mm., and with leaves 5 mm. in length bearing eighteen autozooids. They named it *Scytalium martensii* var. *magnifolia*. Kükenthal was probably right in suggesting that this specimen should more correctly be named *S. sarsii*.

Pteroeides sp. ? juv.

? *Godeffroyia elegans*, Kölliker, 1872, p. 116, pl. viii, figs. 63–65.
? *Pteroeides dofleini*, Balss, 1910, p. 59.

Occurrence.—Station 43, off the S. coast of Arabia, 95 metres. Five small specimens belonging to this genus were collected. They are all probably juvenile forms of some undetermined species.

Descriptive Notes.—Their measurements in millimetres are :

	1.	2.	3.	4.	5.
Total length . . .	58	52	58	58	58
Length of rachis . . .	38	37	?	42	38
Length of stalk . . .	20	15	?	16	20
Longest leaves . . .	12	12	12	12	12

The number of leaves is difficult to count accurately without dissection, but it appears to be twelve to fifteen large plus three to five rudimentary on each side.

The characteristic feature of the leaves is the presence of a very thick dorsal ray composed of several stout overlapping spicules. A number of very slender spicules project from the margin of the leaf, and numerous other slender spicules which do not project penetrate the leaf for a distance of about two-thirds of the width of the leaf, but do not reach its base, leaving a space of about one-third of the width of the leaf free from spicules.

Apart from the dorsal one there are no well-defined rays, but only a large number of slender spicules supporting the outer two-thirds of the leaf.

The siphonozooid plate is basal.

With these two characters the specimens agree most closely with the species originally described by Kölliker as *Godeffroyia elegans* from Siam. At a later date Balss (1910, p. 63) described three specimens from Japan with similar characters, which he called *Pteroeides dofleini* ; but according to Kükenthal this species is identical with *Godeffroyia elegans*, and the specific name " *elegans* " being preoccupied by one of Herklots' species, the name *Pt. dofleini* should stand as that of Kölliker's original species.

All the specimens described by Kölliker and Balss, however, are much larger than any of the " Murray " specimens, ranging in total length from 134–273 mm., and it seems to be a very open question whether these small specimens, 58 mm. in length, from Aden, would grow up with characters similar to those of *Pteroeides dofleini* from the far eastern seas.

Several species of the genus have been described from the east coast of Africa, but the only one which is said to possess a strong dorsal ray and a basal siphonozooid plate is *Pt. isosceles* of J. S. Thomson (1915, p. 17) from 32–38 fathoms off the coast of Natal. The single specimen of this species was 173 mm. in total length, and it bore eighteen rays on the leaves in addition to the strong dorsal ray. It was captured in November, 1900, and bore well-developed gonads.

It seems possible that definite secondary rays might develop from the small spicules of the leaf of the " Murray " specimens if they grew to the size of *Pt. isosceles*, in which case it would be difficult to distinguish them from that species.

Of the species from Zanzibar described by Thomson and Henderson (1906b, p. 438), the only one that might possibly be an adult form of that represented by our specimens

is *Pteroeides rigidum*, 230 mm. in length. It has a variable number of rays (four to six) and a basal siphonozooid plate; but no mention was made of a strong dorsal ray in this species.

The genus *Pteroeides* is widespread in the shallow waters of the tropical and sub-tropical waters of the Old World. In the Indian Ocean seventeen species have been described from the Bay of Bengal by Thomson and Simpson (1909, p. 287) and three species from Zanzibar by Thomson and Henderson (1906B, p. 438); and there are also some earlier records from various localities.

No less than sixty species of the genus have been named, some from isolated and damaged specimens, others from small and therefore probably young specimens. The difficulty of identifying two or three specimens from a new locality is often insuperable, and the tendency to make new species is difficult to resist. The systematics of the genus cannot be placed on a really satisfactory footing until a study has been made of a long series, from small to full-grown, of specimens of the same species from the same locality, in order to ascertain the development in growth of the rays, the siphonozooid plate, the ratio in length of the rachis and stalk and other characters that have been used for the systematic determination of species.

In the present case the only available specimens are very much smaller than adults of other well-known species of the genus, and they are most probably only young stages in the growth of a species which reaches a much larger size. It is therefore better to wait until fresh material is obtained from the same or a neighbouring locality before giving them a new specific name.

Some Additional Notes on the Anatomy of the "Murray" Specimens.

There are twelve or thirteen large leaves and three to five rudimentary ones on each side of the rachis. The large leaves are roughly triangular in outline, reaching a length of 12 mm. along the dorsal border, and a breadth at the base of about 3 mm. The outer margin is somewhat crinkled, but I have been able to count thirty-six autozooids on some of the largest leaves.

The dorsal ray consists of six to eight large, thick, smooth needles, tightly pressed together and overlapping one another. Some of these are 5–6 mm. in length and 0·2 mm. in diameter. The other spicules of the leaf are about 2 mm. in length and 0·06 mm. in diameter. It is difficult to measure accurately many of the spicules when *in situ* in the leaf, and there is, of course, a considerable range in size. The sizes given are those of the largest spicules that could be conveniently measured. But the most striking feature is the great difference in thickness between the spicules of the dorsal ray and all the others.

The siphonozooids are densely crowded together at the base of the leaves to form what is technically known as the basal plate. This plate extends under the dorsal ray for a distance of 4 mm. from the base; it then slopes down to a distance of 1·8 mm. from the base, and at the ventral edge it is only 0·6 mm. from the base. As in most of the species of *Pteroeides* (see Lightbown, 1917, p. 16), there are no mesenteric filaments on these siphonozooids. The stomodæum, as seen in whole mounts, is about $0{\cdot}1 \times 0{\cdot}05$ mm. in cross-section.

Colour.—The specimens are cream-coloured, with very variable but not very extensive patches of black pigment.

Gonads : There is no trace of gonads in the two specimens examined. The date of capture was October 28th.

An Unidentified Pennatulid.

In a tube labelled " Station 145, in the Maldive Archipelago, 494 metres ", there is a very badly preserved Pennatulid which, at first sight, I mistook for a specimen of *Funiculina*.

On the scraps of fleshy substance which remain attached to the axis there are some cylindrical projections similar to the autozooids of a *Funiculina*, but on clearing in oil they were found to be so badly macerated that even the tentacles were not clearly defined, and no trace of siphonozooids could be seen in the surrounding cœnenchym.

The first point to be noticed is that there were no spicules either in the autozooids or the general cœnenchym, but thinking that they might have become macerated off I examined the deposit of mud and other debris at the bottom of the tube and found no spicules.

The second point was that the axis is perfectly cylindrical throughout its whole length, and considerably thicker than that of even the longest specimen of *Funiculina*. It is evident that a considerable piece at the upper end of the specimen has been broken off and lost. What remains has a total length of 380 mm.

The diameter of the axis in the middle of its length is 1·5 mm., but this increases in the upper region of the stalk to a diameter of 2 mm.

Owing to the macerated condition of this specimen it is impossible to determine its systematic position. The cylindrical axis and the absence of spicules prove that it is not a *Funiculina*, and the absence of spicules indicates that it is probably not one of the Protoptilidæ.

The autozooids as preserved are about 5 mm. in length by 1 mm. in diameter, and on one fragment there is a definite arrangement of four in a row. This character suggested that it might be one of the Virgulariidæ, which also have a cylindrical axis and no spicules. The remarkably long and slender autozooids render this suggestion improbable. The only other Pennatulid of great size with a perfectly cylindrical axis and no spicules in the rachis is the *Osteocella septentrionalis* of British Columbia, and in this species the autozooids are of great size (4–5 mm. in length) and arranged in rows.

With the information at our disposal, however, it would be hazardous to identify this specimen from the Maldives with a species so far off and so far north as *Osteocella*.

LITERATURE.

Balss, H. 1910. Japanische Pennatuliden. Doflein. Beiträge zur Naturgeschichte Ostasiens, Abh. bayer. Akad. Wiss. Supplementband. I, no. 10, pp. 106, 5 pls., 9 maps, text illust.

Deichmann, E. 1936. Notes on Pennatulacea, etc. Bull. Bingham Oceanogr. Coll., V, art. 3, pp. 11, text illust.

Fowler, G. H. 1888. On a new *Pennatula* from the Bahamas. Proc. Zool. Soc. Lond., pp. 135–140, pl. vi.

—— 1894. On Two Sea-pens of the Family Veretillidæ from the Madras Museum. Proc. Zool. Soc. Lond., pp. 376–379, pl. xxii.

Hickson, S. J. 1907. Alcyonaria. Brit. Mus. (Nat. Hist.) National Antarctic Expedition, 1901–1904. Nat. Hist. III, pp. 15, 2 pls.

—— 1916. The Pennatulacea. M. Weber. Siboga-Exped. XIV, pp. x, 265, pls. i–x, 1 map, text illust.

—— 1918. Evolution and Symmetry in the Order of the Sea-pens. Proc. Roy. Soc., ser. B, XC, pp. 108–135.

—— 1921. On Some Alcyonaria in the Cambridge Museum. Proc. Camb. Phil. Soc. XX, pp. 366–373.

Jungersen, H. F. E. 1904. Pennatulida. The Danish Ingolf Expedition, V, 1, pp. [1] 95, 3 pls. (col.), text illust.

Kölliker, A. v. 1869–1872. Anatomisch-systematische Beschreibung der Alcyonarien. Abh. senckenb. naturf. Ges. VII, VIII.

—— 1880. Pennatulida. "Challenger" Reports, Zoology, I, 2, pp. 1–41, pls. i–xi.

Kükenthal, W., and Broch, H. 1911. Pennatulacea. Wiss. Ergebn. "Valdivia", XIII, Heft 2, pp. 113–576, pls. 13–19, text illust.

Lightbown, C. M. 1918. On the Dorsal Mesenteric Filaments in the Siphonozooids of Pennatulacea. Mem. Manchester Lit. Phil. Soc. LXII, part i, No. 4, pp. 20, pl. i.

Nutting, C. C. 1908. Descriptions of the Alcyonaria collected by the . . . "Albatross" in the vicinity of the Hawaiian Islands: Pennatulidæ. Proc. U.S. Nat. Mus. XXXIV, p. 557.

Thomson, J. A., and Henderson, W. D. 1906A. The Alcyonarians of the Deep Sea. An Account of the Alcyonarians Collected by the "Investigator", Part I, Calcutta, pp. xvi, 132, 10 pls.

—— —— 1906B. The Marine Fauna of Zanzibar and British East Africa: Alcyonaria. Proc. Zool. Soc. Lond., pp. 393–443, pls. xxvi–xxxi.

—— and Simpson, J. J. 1909. The Alcyonarians of the Littoral Area: An Account of the Alcyonarians Collected by the "Investigator", Part II, Calcutta, pp. xviii, 319, 9 pls., text illust.

Thomson, J. S. 1915. The Pennatulaceæ of the Cape of Good Hope and Natal. Mem. Manchester Lit. Phil. Soc. LIX, No. 1, pp. 26, 2 pls.

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AMPHIPODA

BY

K. H. BARNARD, D.Sc.

WITH TWENTY-ONE TEXT-FIGURES

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WITH TWENTY-ONE TEXT-FIGURES.

For the privilege of reporting on the very interesting collection of Amphipods I have to thank Lt.-Col. R. B. Seymour Sewell; and I am indebted to Dr. Isabella Gordon, of the British Museum, for supplying transcriptions and tracings from works not accessible to me.

The collection is not a very large one. It comprises 116 species, the majority of which are well known Indo-Pacific species. But there are four species whose presence in this region is most unexpected and interesting. It is curious that the collection contains very few representatives of the family Hyperiidæ, except from one station (St. 61). Seven species in the Gammaridea and one in the Caprellidea are described as new.

Historical.—The area explored by the Expedition is almost entirely unworked. Only from the periphery, west, south and east, are there any records of Amphipods. None are known from the central and northern portions of the Arabian Sea, although the R.I.M.S. "Investigator" did some dredging there. The German deep-sea vessel "Valdivia" sailed home from Zanzibar along the East African coast, but apparently collected no Gammarids, only Hyperiids.

For our knowledge of the Amphipods of the Red Sea we have the reports of Kossmann, Walker, Spandl (S.M.S. "Pola"), Cecchini, and Schellenberg (Cambridge Suez Canal Expedition); of the Seychelles, Chagos, Maldive and Laccadive area the reports of Walker (Percy Sladen Expeditions) and Chevreux (Mission de M. Alluaud); of Socotra and Abd-el-Kuri Walker and Scott's report on Dr. Forbes' collecting; and of Zanzibar the early records of Hyperiids by Claus and a later paper by Walker.

Distribution.—For each Indo-Pacific species captured by the John Murray Expedition I have thought it useful to set out in detail the localities in the Indian Ocean from which it has previously been recorded, including in this region the Red Sea, the southern portion of the Indian Ocean to about lat. 20° S., and the East Indies as far as long. 100° E.

The western Indian Ocean might perhaps be regarded as a faunal unit, a good few of whose members may extend along the east coast of Africa as far as the southern point of the continent. The fact that some of the Amphipods (and Isopods) of this fauna have been described from South Africa prior to their discovery farther north is due to the incidence of collecting and is quite accidental. Their presence in South Africa is to be

ascribed to the Mozambique-Agulhas current. As examples may be cited *Lysianassa variegata*, *Stomacontion capense*, *Ampithoë falsa*, *Podocerus palinuri* and *africanus*.

Greater interest attaches to the four deep-water species *Koroga megalops* (St. 131), *Thoriella islandica* (St. 76), *Sympleustes grandimanus* (St. 54), and *Eurythenes gryllus* (St. 170). The last-mentioned species has been found in several other parts of the world and its presence in the central Arabian Sea is not very surprising. *Koroga* has been found (two specimens only) off Alaska and Iceland. *S. grandimanus* and *Thoriella* are both North Atlantic forms. The specimen of *Thoriella* is by far the most valuable Amphipodan specimen collected by the Expedition, as only one other specimen has ever been captured.

A satisfactory explanation of the presence of these two last-mentioned Atlantic forms in deep water off the Oman coast is not easy to give. They are not the only " awkward customers " to deal with, as Lt.-Col. Seymour Sewell informs me that he has previously found two or three species of Arctic Copepods in Indian waters ; and I have recently recorded (1936, ' Rec. Indian Mus.', xxxviii, p. 157) from among the Isopods collected by the " Investigator " specimens of the North Atlantic *Æga ventrosa* from the northern part of the Arabian Sea and from near the Maldives. Is it too unreasonable to regard these deep-water forms from the Arabian Sea as relics of the Cretaceo-Tertiary Sea of Tethys ?

The two Hyperiids, *Mimonectes chevreuxi* (St. 172) and *Proscina stephenseni* (St. 131) are also noteworthy. The former has been found in the East Indies as well as in the Atlantic, but the latter has hitherto been known only from the Atlantic.

Clearly there is need of many more deep-sea expeditions.

LIST OF SPECIES COLLECTED.

Gammaridea.

Lysianassidæ :
- *Stomacontion pepinii* (Stebb.).
- *S. capense* Brnrd.
- *Amaryllis macrophthalma* Hasw.
- *Cyphocaris faurei* Brnrd.
- *C. anonyx* Boeck.
- *C. challengeri* Stebb.
- *Lysianassa cinghalensis* (Stebb.).
- *L. cœlochir* Wlkr.
- *L. variegata* (Stmpsn.).
- *Aristias* sp.
- *Eurythenes gryllus* (Licht.).
- *Microlysias indica* n. sp.
- *Koroga megalops* Holmes.
- *Thoriella islandica* Steph.

Hyperiopsidæ :
- *Hyperiopsis tridentata* n. sp.

Stegocephalidæ :
- *Parandania boecki* (Stebb.).

Ampeliscidæ :
- *Ampelisca brevicornis* (Costa).
- *A. tenuicornis* Lilj.
- *A. zamboangæ* Stebb.
- *A. cyclops* Wlkr.
- *A.* cf. *abyssicola* Stebb.
- *A.* cf. *daleyi* Giles.
- *Byblis lepta* (Giles).

Amphilochidæ :
- *Amphilochus neapolitanus* Della Valle.

Leucothoidæ :
- *Leucothoë spinicarpa* (Abildg.).
- *L. furina* (Say).
- *Leucothoëlla bannwarthi* Schell.

Stenothoidæ :
- *Stenothoë antennulariæ* Della Valle.
- *S. gallensis* Wlkr.

Colomastigidæ :
- *Colomastix pusilla* Grube.

Gammaridea (*continued*).

Acanthonotozomatidæ :
Iphimedia gladiolus n. sp.

Synopiidæ :
Synopia ultramarina Dana.

Œdicerotidæ :
Œdiceroides antennatus n. sp.
Œ. zanzibaricus n. sp.

Pleustidæ :
Sympleustes grandimanus (Chevr.).

Eusiridæ :
Eusiropsis riisei Stebb.

Gammaridæ :
Melita fresnelii (Aud.).
Mœra inæquipes (Costa).
Ceradocus rubromaculatus (Stmpsn.).
Elasmopus subcarinatus (Hasw.).
E. pectenicrus Bate.
E. erythræus (Kossm.).

Dexaminidæ :
Polycheria atolli Wlkr.

Talitridæ :
Hyale nigra (Hasw.).

Aoridæ :
Lembos podoceroides Wlkr.

Photidæ :
Photis longicaudata (B. & W.).
P. dolichommata Stebb.
Eurystheus atlanticus (Stebb.).
E. imminens Brnrd.
E. afer (Stebb.).
E. lophomeria n. sp.
Cheiriphotis megacheles (Giles).
Chevalia aviculæ Wlkr.

Ampithoidæ :
Ampithoë ramondi (Aud.).
A. falsa Brnrd.
Grubia filosa (Sav.).
Sunamphitoë orientalis (Dana).

Corophiidæ :
Ericthonius brasiliensis (Dana).
Cerapus abditus Templeton.
Siphonœcetes orientalis Wlkr.

Podoceridæ :
Podocerus palinuri Brnrd.
P. africanus Brnrd.
Lætmatophilus leptocheir n. sp.

Hyperiidea.

Lanceolidæ :
Lanceola sayana Bov.

Mimonectidæ :
Mimonectes chevreuxi (Pirlot).

Scinidæ :
Proscina stephenseni (Pirlot).
Scina crassicornis (Fabr.).
S. curvidactyla Chevr.
S. borealis (G. O. Sars).
S. marginata Bov.

Vibiliidæ :
Vibilia propinqua Stebb.
V. armata Bov.
V. pyripes Bov.

Paraphronimidæ :
Paraphronima gracilis Claus.
P. crassipes Claus.

Hyperiidæ :
Hyperia promontorii Stebb.
H. crucipes Bov.
Hyperioides longipes Chevr.

Dairellidæ :
Dairella latissima Bov.

Phronimidæ :
Phronima sedentaria (Forsk.).
P. atlantica Guér.
P. atlantica var. *solitaria* Guér.
P. colletti Bov.
Phronimella elongata (Claus).

Phrosinidæ :
Phrosina semilunata Risso.
Primno macropa Guér.
Anchylomera blossevillei M. Edw.

HYPERIIDEA (*continued*).

Pronoidæ :
Pronoë capito Guér.
Eupronoë maculata Claus.
E. armata Claus.
Parapronoë crustulum Claus.
Sympronoë parva (Claus).

Lycœidæ :
Lycœa pulex Marion.

Brachyscelidæ :
Brachyscelus globiceps Claus.
Thamneus platyrhynchus Stebb.

Oxycephalidæ :
Simorhynchotus antennarius (Claus).
Oxycephalus clausi Bov.
Streetsia challengeri Stebb.
S. porcellus (Claus).
Glossocephalus milne-edwardsi Bov.
Rhabdosoma whitei Bate.
Leptocotis tenuirostris (Claus).

Platyscelidæ :
Platyscelus ovoides (Claus).
P. armatus Stebb.
P. inermis (Claus).
Hemityphis crustulum Claus.
Tetrathyrus forcipatus Claus.
Paratyphis maculatus Claus.
P. parvus Claus.
Amphithyrus bispinosus Claus.
A. sculpturatus Claus.

Thyropidæ :
Thyropus sphæroma Claus.

CAPRELLIDEA.

Caprellidæ :
Caprella danilevskii Czern.
Paradeutella bituberculata n. sp.
Monoliropus falcimanus Mayer.
Hemiægina ? minuta Mayer.

LIST OF STATIONS AT WHICH AMPHIPODA WERE CAPTURED, WITH THE SPECIES OBTAINED AT EACH STATION.

RED SEA.

St. 5. 13.ix.33. 2 m. tow-net. 300–0 metres, oblique.
Phronima sedentaria (Forsk.), *Platyscelus inermis* (Claus).

St. 7. 16.ix.33. 2 m. plankton net. 100–0 fathoms, oblique.
Phronima sedentaria (Forsk.), *P. atlantica* var. *solitaria* Guér., *Rhabdosoma whitei* Bate.

St. 9. 17.ix.33. Otter trawl. 30 fathoms.
Leucothoë spinicarpa (Abildg.).

St. 10. 17.ix.33. Otter trawl. 30 fathoms.
Stomacontion pepinii (Stebb.), *Ampelisca zamboangæ* Stebb., *Leucothoë spinicarpa* (Abildg.), *Leucothoëlla bannwarthi* Schell., *Stenothoë gallensis* Wlkr., *Colomastix pusilla* Grube, *Melita fresnelii* (Aud.), *Mœra inœquipes* (Costa), *Ceradocus rubromaculatus* (Stmpsn.), *Eurystheus atlanticus* (Stebb.), *E. imminens* Brnrd., *Chevalia aviculæ* Wlkr.

St. B. 17.ix.33. Rectangular dredge. 16 fathoms.
Amaryllis macrophthalma Hasw., *Lysianassa cinghalensis* (Stebb.), *Ampelisca zamboangæ* Stebb., *Leucothoë spinicarpa* (Abildg.), *Elasmopus erythræus* (Kossm.), *Polycheria atolli* Wlkr., *Ericthonius brasiliensis* (Dana).

St. D. 17.ix.33. Rectangular dredge. 13 fathoms.
Mœra inæquipes (Costa).

Cape Guardafui.

St. 22. 5.x.33. From Sargassum weed caught on log-line.
Ampithoë falsa Brnrd.

St. 24. 9.x.33. Otter trawl. 60–120 fathoms.
Melita fresnelii (Aud.).

St. 27. 12.x.33. Otter trawl. 15–40 fathoms.
Lembos podoceroides Wlkr., *Photid* juv. (not identified).

Gulf of Aden.

St. 31. 13.x.33. Weed adrift on surface.
Ampithoë falsa Brnrd.

St. 39. 25.x.33. Hand-net at surface.
Glossocephalus milne-edwardsi Bov.

Kuria Muria Islands and Southern Arabian Coast.

St. 41. 27.x.33. Anchorage. Hand-net at surface.
Eurystheus atlanticus (Stebb.), *Sunamphitoë orientalis* (Dana).

St. MB II A. 28.x.33. Rectangular dredge. 5 fathoms.
Hyale nigra (Hasw.), *Eurystheus atlanticus* (Stebb.), *Grubia filosa* (Sav.), *Caprella danilevskii* Czern.

St. MB II C. 28.x.33. Rectangular dredge. 16 fathoms.
Ampelisca tenuicornis Lilj., *Lembos podoceroides* Wlkr., *Photis longicaudata* (B. & W.), *Cerapus abditus* Templeton, *Siphonœcetes orientalis* Wlkr.

St. 45. 29.x.33. Triangular dredge. 40 metres.
Amaryllis macrophthalma Hasw., *Byblis lepta* (Giles), *Amphilochus neapolitanus* Della Valle, *Leucothoë spinicarpa* (Abildg.), *Stenothoë antennulariæ* Della Valle, *Iphimedia gladiolus* n. sp., *Elasmopus subcarinatus* (Hasw.), *Lembos podoceroides* Wlkr., *Photis longicaudata* (B. & W.), *Eurystheus atlanticus* (Stebb.), *Chevalia aviculæ* Wlkr., *Ericthonius brasiliensis* (Dana), *Cerapus abditus* Templeton, *Podocerus palinuri* Brnrd., *Lætmatophilus leptocheir* n. sp., *Paradeutella bituberculata* n. sp., *Monoliropus falcimanus* Mayer.

St. Extra. 1.xi.33. Shore collecting, southern Arabian coast. On Sargassum weed.
Stomacontion capense Brnrd., *Ampelisca tenuicornis* Lilj., *Hyale nigra* (Hasw.), *Ampithoë ramondi* (Aud.), *Ericthonius brasiliensis* (Dana), *Podocerus africanus* Brnrd., *Hemiægina ? minuta* Mayer.

St. 53. 2.xi.33. Triangular dredge. 13½ metres.
Microlysias indica n. sp., *Leucothoë furina* (Sav.), *Mœra inœquipes* (Costa), *Elasmopus pectenicrus* Bate, *E. erythrœus* (Kossm.), *Photis dolichommata* Stebb., *Eurystheus lophomeria* n. sp., *Cheiriphotis megacheles* (Giles), *Ericthonius brasiliensis* (Dana), *Cerapus abditus* Templeton.

Northern Arabian Sea.

St. 54. 3.xi.33. Agassiz trawl. 952 metres.
Sympleustes (*Dautzenbergia*) *grandimanus* (Chevr.).

St. 61. 8.xi.33. Day. 1 m. tow-net. 570 metres wire out.
Vibilia pyripes Bov., *Phronima atlantica* Guér., *Rhabdosoma whitei* Bate.

St. 61. 8.xi.33. Day. 1 m. tow-net. 1136 metres wire out.
Vibilia pyripes Bov., *Brachyscelus globiceps* Claus, *Streetsia challengeri* Stebb.

St. 61. 8.xi.33. Day. 1 m. tow-net. 1702 metres wire out.
Cyphocaris faurei Brnrd., *Hyperiopsis tridentata* n. sp., *Lanceola sayana* Bov., *Vibilia armata* Bov., *V. pyripes* Bov., *Phronima atlantica* var. *solitaria* Guér., *Phronimella elongata* (Claus), *Streetsia challengeri* Stebb.

St. 61. 8.xi.33. Day. 2 m. tow-net. 2265 metres wire out.
Phronima sedentaria (Forsk.), *Streetsia challengeri* Stebb.

St. 61. 8–9.xi.33. 50 cm. tow-net, surface.
Synopia ultramarina Dana, *Hyperia promontorii* Stebb., *Phronima colletti* Bov., *Phronimella elongata* (Claus), *Anchylomera blossevillei* M. Edw., *Lycœa pulex* Marion, *Brachyscelus globiceps* Claus, *Thamneus platyrhynchus* Stebb., *Simorhynchotus antennarius* (Claus), *Amphithyrus bispinosus* Claus, *Thyropus sphæroma* Claus.

St. 61. 8–9.xi.33. Night. 1 m. tow-net. 1136 metres wire out.
Scina marginata Bov., *Vibilia armata* Bov., *V. pyripes* Bov., *Paraphronima gracilis* Claus, *Phronima colletti* Bov., *Phronimella elongata* (Claus), *Phrosina semilunata* Risso, *Anchylomera blossevillei* M. Edw., *Eupronoë maculata* Claus, *Sympronoë parva* (Claus), *Streetsia challengeri* Stebb., *S. porcellus* (Claus), *Leptocotis tenuirostris* (Claus), *Hemityphis crustulum* Claus.

St. 61. 8–9.xi.33. Night. 1 m. tow-net. 1702 metres wire out.
Cyphocaris faurei Brnrd., *Vibilia armata* Bov., *Phronima colletti* Bov., *Phronimella elongata* (Claus), *Phrosina semilunata* Risso, *Anchylomera blossevillei* M. Edw., *Sympronoë parva* (Claus), *Streetsia challengeri* Stebb., *S. porcellus* (Claus), *Rhabdosoma whitei* Bate, *Hemityphis crustulum* Claus, *Tetrathyrus forcipatus* Claus, *Thyropus sphæroma* Claus.

St. 61. 8–9.xi.33. Night. 1 m. tow-net. 2265 metres wire out.
Cyphocaris faurei Brnrd., *Vibilia pyripes* Bov., *Phronima sedentaria* (Forsk.), *Phrosina semilunata* Risso.

Gulf of Oman.

St. 71. 26.xi.33. Otter trawl. 106 metres.
Lysianassa cinghalensis (Stebb.).

St. 74. 27.xi.33. Petersen grab. 160 metres.
Lysianassa cœlochir (Wlkr.). *Ampelisca cyclops* Wlkr.. *Byblis lepta* (Giles).

St. 76 A. 29.xi.33. 50 cm. silk net, surface.
Hyperia crucipes Bov.

St. 76 B. 29.xi.33. 1 m. tow-net. 300 metres wire out.
Rhabdosoma whitei Bate.

St. 76 B. 29.xi.33. 1 m. tow-net. 800 metres wire out.
Vibilia armata Bov.

St. 76 B. 29.xi.33. 1 m. tow-net. 1800 metres wire out.
Vibilia armata Bov., *V. pyripes* Bov.

St. 76 B. 29.xi.33. 2 m. tow-net. 2800 metres wire out.
Cyphocaris faurei Brnrd., *Thoriella islandica* Steph.

Central Arabian Sea.

St. 94. 17.xii.33. 2 m. tow-net. 1400 metres wire out.
Lanceola sayana Bov.

St. 95. 18.xii.33. 2 m. tow-net. 1400 metres wire out.
Vibilia propinqua Stebb., *Phronima sedentaria* (Forsk.).

St. 96. 19.xii.33. 1 m. tow-net. 15 metres wire out.
Oxycephalus clausi Bov.

St. 96. 19.xii.33. 2 m. tow-net. 914 metres wire out.
Lanceola sayana Bov., *Scina crassicornis* (Fabr.), *Vibilia armata* Bov., *Phronima sedentaria* (Forsk.), *Oxycephalus clausi* Bov., *Amphithyrus bispinosus* Claus.

St. 98. 22.xii.33. 2 m. tow-net. 2800 metres wire out.
Phronima sedentaria (Forsk.).

St. 101. 27.xii.33. Hand-net, surface.
Hyperia crucipes Bov., *Thamneus platyrhynchus* Stebb.

Zanzibar Area.

St. 105. 11.i.34. Agassiz trawl. 310 metres.
Ampelisca cf. *abyssicola* Stebb., *Eurystheus afer* (Stebb.).

St. 108. 13.i.34. Agassiz trawl. 802 metres.
Phronima sedentaria (Forsk.), *Platyscelus ovoides* (Claus).

St. 110. 14.i.34. Otter trawl. 333 metres.
Eurystheus afer (Stebb.).

St. 111. 14.i.34. Agassiz trawl. 50 fathoms.
Leucothoë spinicarpa (Abildg.), *Eurystheus* sp. ?

St. 112. 15.i.34. Petersen grab. 118 metres.
Lysianassa variegata (Stmpsn.), *Leucothoë spinicarpa* (Abildg.), *Melita fresnelii* (Aud.), *Eurystheus* sp. ?

St. 119. 19.i.34. Agassiz trawl. 1228 metres.
Œdiceroides antennatus n. sp., *Platyscelus ovoides* (Claus).

St. 120. 20.i.34. Agassiz trawl. 2900 metres.
Œdiceroides zanzibaricus n. sp., *Parapronoë crustulum* Claus.

St. 121. 21.i.34. Agassiz trawl. 510 fathoms.
Phronima sedentaria (Forsk.), *Platyscelus ovoides* (Claus).

St. 122. 23.i.34. Otter trawl. 762 metres.
Oxycephalus clausi Bov.

Southern Arabian Sea (Seychelles).

St. 131 A. 10–11.ii.34. Night. 2 m. tow-net. 600–0 metres vertical.
Scina crassicornis (Fabr.), *S. curvidactyla* Chevr., *Primno macropa* Guér., *Phrosina semilunata* Risso.

St. 131 D. 11.ii.34. Day. 1 m. tow-net. 500–0 metres vertical.
Phronimella elongata (Claus).

St. 131 D. 11.ii.34. Day. 1 m. tow-net. 1500–0 metres vertical.
Cyphocaris challengeri Stebb., *Koroga megalops* Holmes, *Proscina stephenseni* (Pirlot), *Paraphronima crassipes* Claus, *Phrosina semilunata* Risso, *Primno macropa* Guér.

St. 131 D. 11.ii.34. Day. 2 m. tow-net. 2500–0 metres vertical.
Phronima sedentaria (Forsk.), *Oxycephalus clausi* Bov.

Maldive Islands Area.

St. 136. 21.iii.34. Hand-net, surface.
Hyperia sp.

St. 145 C. 1.iv.34. 1 m. tow-net. 50–0 metres vertical.
Vibilia sp.

St. 145 D. 2.iv.34. 1 m. tow-net. 300–0 metres vertical.
Vibilia armata Bov., *Eupronoë armata* Claus.

Maldive Islands.

St. 157. 6.iv.34. Triangular dredge. 120 fathoms.
Aristias sp., *Ampelisca* cf. *daleyi* Giles.

Minikoi.

St. 164. 11.iv.34. Petersen grab. 210 metres.
Byblis lepta (Giles).

Central Arabian Sea.

St. 170. 27.iv.34. Agassiz trawl. 3685 metres.
Eurythenes gryllus (Licht.).

St. 172. 29.iv.34. 1 m. tow-net. 510 metres wire out.
Cyphocaris faurei Brnrd., *C. anonyx* Boeck, *Eusiropsis riisei* Stebb., *Scina curvidactyla* Chevr., *Hyperia crucipes* Bov., *Phronima sedentaria* (Forsk.), *Primno macropa* Guér., *Phrosina semilunata* Risso, *Pronoë capito* Guér., *Parapronoë crustulum* Claus, *P. clausoides* Stebb., *Brachyscelus globiceps* Claus, *Paratyphis parvus* Claus, *Amphithyrus bispinosus* Claus.

St. 172. 29.iv.34. 1 m. tow-net. 820 metres wire out.
Paraphronima crassipes Claus, *Parapronoë crustulum* Claus, *Brachyscelus globiceps* Claus, *Streetsia challengeri* Stebb.

St. 172. 29.iv.34. 1 m. tow-net. 1500 metres wire out.
Mimonectes chevreuxi (Pirlot). *Phrosina semilunata* Risso, *Oxycephalus clausi* Bov., *Platyscelus armatus* Stebb.

St. 172. 29.iv.34. 2 m. tow-net. 2665 metres wire out.
Parandania boecki (Stebb.). *Phronima sedentaria* (Forsk.), *Phrosina semilunata* Risso, *Parapronoë crustulum* Claus, *Oxycephalus clausi* Bov.

Gulf of Aden.

St. 179 A. 2.v.34. Grab. 310 metres.
Ampelisca brevicornis (Costa).

St. 184. 4.v.34. Agassiz trawl. 1270 metres.
Phronima sedentaria (Forsk.).

St. 186. 5.v.34. 1 m. tow-net. 510 metres wire out.
Paraphronima crassipes Claus. *Eupronoë maculata* Claus. *Sympronoë parva* (Claus), *Streetsia challengeri* Stebb., *Paratyphis maculatus* Claus, *Amphithyrus bispinosus* Claus.

St. 186. 5.v.34. 1 m. tow-net. 880 metres wire out.
Scina curvidactyla Chevr., *Phronima sedentaria* (Forsk.).

St. 186. 5.v.34. 1 m. tow-net. 1150 metres wire out.
Scina borealis (Sars). *Hyperioides longipes* Chevr., *Dairella latissima* Bov., *Phronima colletti* Bov., *Brachyscelus globiceps* Claus, *Leptocotis tenuirostris* (Claus).

St. 186. 5.v.34. 2 m. tow-net. 1500 metres wire out.
Phronima sedentaria (Forsk.), *Eupronoë maculata* Claus, *Rhabdosoma whitei* Bate.

SYSTEMATIC ACCOUNT.

GAMMARIDEA.

Family Lysianassidæ.

Gen. *Stomacontion* Stebb.

Stebbing, 1906, p. 16.
Barnard, 1916, p. 109, and 1932, p. 33.

Stomacontion pepinii (Stebb.).

Stebbing, 1888, p. 716, pl. 32, and p. 720, pl. 33 (*kergueleni*).
„ 1906, p. 16.

Occurrence :

St. 10. Red Sea. 1 specimen 4 mm.

Remarks.—It is perhaps rather surprising to find this species in the Red Sea, but a comparison with Stebbing's pl. 32 (*pepinii*) discloses no differences.

Distribution.—Kerguelen, 28 fathoms.

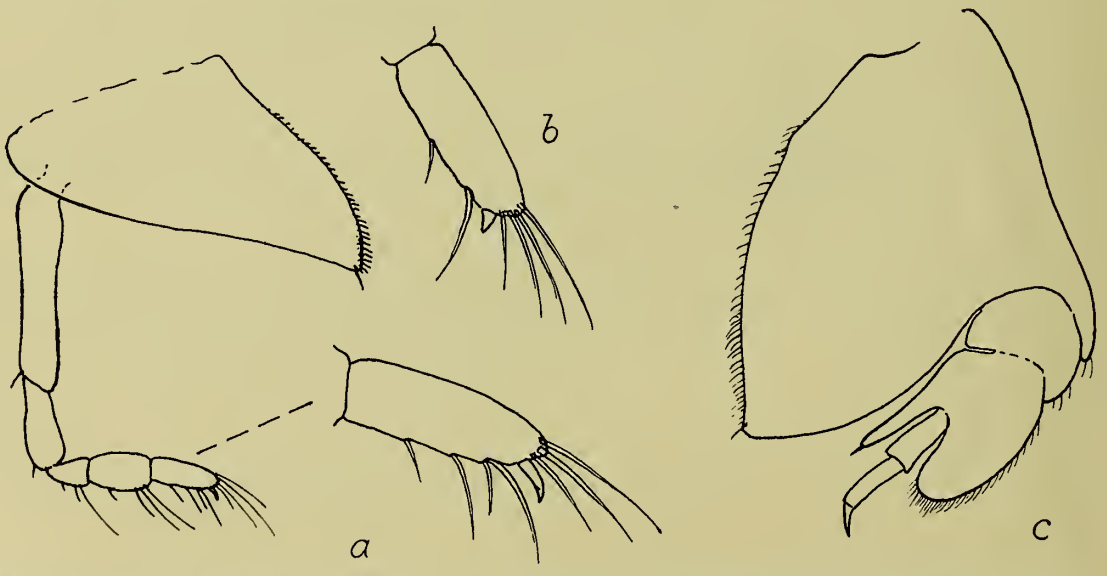
Stomacontion capense Brnrd. (Text-fig. 1.)

Barnard, 1916, p. 109, pl. 28, figs. 27, 28.

Occurrence :

St. Extra. Southern Arabian coast. 2 ♂♂ 2 mm.

Remarks.—Comparison with the type shows these specimens to be in essential agreement, but the following additional features may be mentioned as separating this species from *pepinii*.



Text-fig. 1.—*Stomacontion capense* Brnrd. *a*, Side-plate 1 and gnathopod 1, with apex further enlarged. *b*, Apex of gnathopod 1. *c*, Peræopod 5. (*a*, From the type, S. Africa ; *b*, *c*, from John Murray Expedition.)

Lower margins of side-plates 2 and 3, and to a lesser extent also 4, minutely nodulose, giving an undulate appearance (very obscure in the Cape specimen). Gnathopod 1, 2nd joint shorter and 3rd joint longer than in *pepinii*, the 3rd joint continuing the line of the 2nd, the bend in the limb occurring at the junction of 3rd and 4th joints (both the present specimens and the Cape one are preserved with the limb in this flexed position); 6th joint more slender, but very little longer, than the 5th (not considerably longer as in *pepinii*); dactylus greatly reduced, more so in the present specimens than in the type. Peræopod 5, 2nd joint differing in shape from that of *pepinii*, triangular, the anterior margin nearly straight; 4th joint with the posterior process very slender, almost spiniform, the anterior strongly convex; 5th–7th joints more slender than in *pepinii*.

Distribution.—False Bay, South Africa, 24 fathoms.

Gen. *Amaryllis* Hasw.

Stebbing, 1906, p. 23, and p. 717 (*Vijaya*).

Amaryllis macrophthalma Hasw.

Walker, 1904, p. 241, pl. 1, fig. 5 (*Vijaya tenuipes*).
,, 1909, p. 327.
Barnard, 1916, p. 114.
Pirlot, 1933, p. 122.

Occurrence :

St. B. Red Sea. 1 specimen 5 mm.

St. 45. Southern Arabian coast. 1 ♀ with embryos 8 mm., 1 specimen 7 mm., 2 specimens 4·5 mm.

Recorded Localities in Indian Ocean.—Ceylon and Wasin, B.E.A. (Walker).

Distribution.—East Indies; Australasia; South Africa.

Gen. *Cyphocaris* Boeck.

Schellenberg, 1926*a*, p. 202.
Barnard, 1932, p. 34.
Shoemaker, 1934 (Smithson. Misc. Coll., Washington, xcl, No. 2), p. 1.

Cyphocaris faurei Barnard.

Barnard, 1916, p. 117, pl. 26, fig. 4, and 1932, p. 36.
Schellenberg, 1926*a*, p. 215, text-figs. 2*e*, 11, 12, and pl. 5, fig. 4.
Pirlot, 1933, p. 128.

Occurrence :

St. 61 (day, 1702 metres wire out). Northern Arabian Sea. 1 specimen 14 mm.

St. 61 (night, 1702 metres wire out). 1 ♀ 15 mm., 2 juv. 5 mm.

St. 61 (night, 2265 metres wire out). 2 ♀♀ 15 and 17 mm., 1 ♀ 20 mm. with embryos 5 mm.

St. 76. Gulf of Oman. 1 ovig. ♀ 18 mm.

St. 172. Central Arabian Sea. 1 specimen about 14 mm. (head missing).

Remarks.—The hind margin of 2nd joint in peræopods 4 and 5 in the specimen from St. 61 (day) has a few strong serrations, and is strongly serrate in that from St. 172

(*cf.* Schellenberg's fig. 12); in the latter specimen the spur of peræopod 3 has one small adpressed tooth on upper margin.

DISTRIBUTION.—Atlantic; South Africa; East Indies; Eastern Pacific.

Cyphocaris anonyx Boeck.

Schellenberg, 1926*a*, p. 210, figs. 2*b*, 5*a*, *b*, and pl. 5, fig. 2.
Barnard, 1932, p. 36.
Pirlot, 1933, p. 127.

OCCURRENCE:

St. 172 (510 metres wire out). Central Arabian Sea. 1 specimen 8 mm.

RECORDED LOCALITIES IN INDIAN OCEAN.—3°–10° S. 51°–97° E. (Schellenberg).

DISTRIBUTION.—Atlantic; East Indies; Pacific.

Cyphocaris challengeri Stebb.

Walker, 1909, p. 327 (*alicei*).
Schellenberg, 1926*a*, p. 212, figs. 2*d*, 6–10, and pl. 5, fig. 3.
Barnard, 1932, p. 36.
Pirlot, 1933, p. 128.

OCCURRENCE:

St. 131 (day, 1500 metres). Southern Arabian Sea. 2 ovig. ♀♀ 10 mm., 1 immat. 7·5 mm.

RECORDED LOCALITIES IN INDIAN OCEAN.—Seychelles (Walker), 0°–4° S. 53°–98° E. (Schellenberg).

DISTRIBUTION.—Atlantic; East Indies; Pacific.

Gen. *Lysianassa* M. Edw.

Stebbing, 1906, pp. 37, 718.
Pirlot, 1936, p. 257.

Lysianassa cinghalensis (Stebb.).

Stebbing, 1897, p. 28, pl. 7A.
Walker, 1909, p. 328.

OCCURRENCE:

St. B. Red Sea. 1 ♂ 5·5 mm.

St. 71. Gulf of Oman. 1 immat. ♀ 6·5 mm.

REMARKS.—First joint of antenna 1 stout, without apical teeth. Notch on lower hind corner of side-plate 1 obsolete. Hand of gnathopod 2 as figured by Stebbing. Peræopods 1 and 2 not so slender as represented in Stebbing's figures. Peræopod 5, 2nd joint without any angle at the junction of hind and lower margins (contrast *bispinosa*, Chevreux and Fage, 1925, fig. 24). Uropod 2, rami slender, inner ramus feebly constricted. Uropod 3, peduncle slender, not or very feebly keeled, ending in a short point (*cf. bispinosa*, Chevreux and Fage, 1925, fig. 24). Telson appreciably longer than broad, apically rounded.

Except for the obsolete notch (figured but not mentioned by Stebbing) on side-plate 1, these specimens appear to agree with Stebbing's specimen. Beyond saying that I do not agree with Walker (1904, p. 242) in making *urodus* a synonym (the 3rd uropods are

quite different), I am not prepared to discuss the possible synonymy of this species. Walker's 1904 and 1905 records I regard as *sub judice*.

Recorded Localities in Indian Ocean.—Ceylon (Stebbing); Seychelles (Walker).

Lysianassa cœlochir (Wlkr.).

Walker, 1904, p. 243, pl. 1, fig. 7.
? Walker & Scott, 1903, p. 220, pl. 14a, fig. 4 (*urodus*).

Occurrence :

St. 74. Gulf of Oman. 1 ovig. ♀ 7 mm.

Remarks.—First joint of antenna 1 stout, without apical teeth. Side-plate 1 with notch near lower hind corner. Gnathopod 2. 6th joint distally expanded, palm concave. dactylus strongly curved. Peræopod 5, 2nd joint with no angle at junction of hind and lower margins. Uropod 2, inner ramus feebly constricted. Uropod 3, peduncle distinctly keeled on upper outer edge, inner edge very feebly keeled (see Walker's figure). Telson a little longer than broad. apically truncate, with rounded angles.

The keeled peduncle of uropod 3 is a clear distinction, in addition to the hand of gnathopod 2, between this and the preceding species. The hand of gnathopod 2 of *urodus* was not described or figured. but there is some resemblance between the 1903 and 1904 figures of the 3rd uropods.

Recorded Locality in Indian Ocean.—Ceylon (Walker); ? Abd-el-Kuri (Walker & Scott).

Lysianassa variegata (Stimpson).

Stebbing, 1888, p. 682, pl. 23.
,, 1906, p. 39.
,, 1910*a*, p. 449.

Occurrence :

St. 112. Zanzibar area. 1 ♀ 6·5 mm.

Remarks.—This specimen agrees with South African examples. The hand of gnathopod 2 is usually rather more parallel-sided than in Stebbing's figure, and the palm is usually concave (but transverse, not oblique, as in *cœlochir*), with a series of minute denticles around the inner and outer edges of the concavity (Stebbing's figure shows them on the one side only). There is a small tooth on lower apex of 1st joint of antenna 1.

The keel on peduncle of uropod 3 is not described by Stebbing, and his figure does not show it very clearly. The peduncle itself is not so stout and the keel is not so strong as in Chilton's figure (1912, ' Trans. Roy. Soc. Edinb.', xlviii, pl. 1, fig. 5) of the species there called *cubensis*.

Distribution.—South Africa (False Bay to East London).

Gen. *Aristias* Boeck.

Stebbing, 1906, pp. 49, 718.
Barnard, 1916, p. 121, and 1932, p. 43.

Aristias sp.

Occurrence :

St. 157. Maldives. 1 specimen 3·5 mm.

Remarks.—Resembles *megalops* Sars and *symbiotica* Brnrd. in the 2-jointed accessory flagellum, the telson, and the 3rd uropods. Eyes well developed, though not as large as in *megalops*, reddish.

With only one specimen available, I do not feel inclined to give a specific name. This is the first record of the genus in the Indian Ocean.

Gen. *Eurythenes* S. I. Smith.

Barnard, 1932, p. 58, and p. 55 (*Katius*).
Stephensen, 1933 (Medd. om Grönland, Bd. lxxix), p. 12.

Eurythenes gryllus (Licht.).

Barnard, 1932, p. 56, fig. 21, and pl. 1, fig. 1 (*Katius obesus*).
Stephensen, 1933 (*l.c. supra*), p. 12, figs. 4–7.

Occurrence :

St. 170. Central Arabian Sea. 1 ♀ (immature, but with oostegites) 48 mm.

Distribution.—North and South Atlantic ; North Pacific.

Gen. *Microlysias* Stebb.

Stebbing, 1918, p. 63.

Remarks.—An important character not mentioned by Stebbing is : branchiæ pleated on both sides. Both lobes of maxilla 2 are narrow. The genus is perhaps allied to *Lysianella*, in which the *penultimate* peduncular joint of antenna 2 is enlarged.

Microlysias indica n. sp. (Text-fig. 2.)

Occurrence :

St. 53. South Arabian Coast. 1 ♂ 6 mm., 3 ♀♀ 4·5–6 mm., 1 juv. 3 mm.

Description.—Very similar to *xenokeras* Stebb., but distinguished by the different profile of epistome and upper lip. In both species the 5th joint of gnathopod 1 has the lower apex projecting as a narrow lobe alongside the lower margin of 6th joint (*cf. Orchomenopsis nodimanus* Wlk.), and the telson is rather more deeply cleft than in Stebbing's figure (1918, pl. 10). Postero-inferior angle of pleon segment 3 rounded-quadrate, the hind margin with one or a very few obscure indents. Hind margins of 2nd joints of peræopods 3–5 with numerous but feeble serrations.

Remarks.—I have not seen any of Stebbing's original specimens (or indeed any from the type locality—Durban), but I have compared specimens from Plettenberg Bay, which it is reasonable to assume belong to Stebbing's species, with the above specimens from the John Murray Expedition. Both Stebbing's specimens and those collected by myself at Plettenberg Bay were found in Sea-squirts (Ascidians) but there are no data with regard to the John Murray specimens.

The present species has a strong superficial resemblance to species of *Orchomenella* (*e. g. nana*, which has been reported from Ceylon), but is easily distinguished by the doubly-pleated branchiæ and the widely expanded 4th joints of peræopods 3–5.

Gen. *Koroga* Holmes.

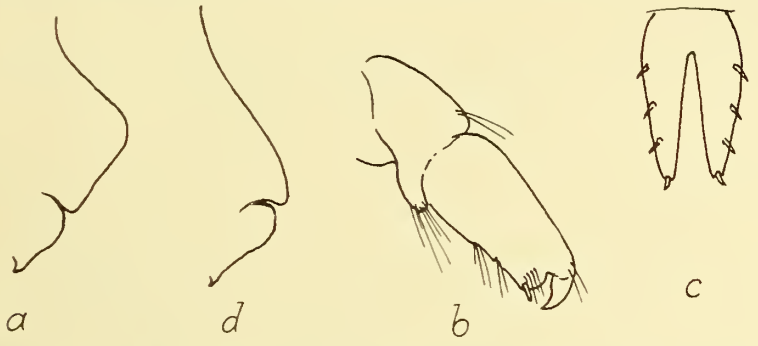
Holmes, 1908 (Proc. U.S. Nat. Mus. xxxv, 1909), p. 502.

Koroga megalops Holmes. (Text-fig. 3.)

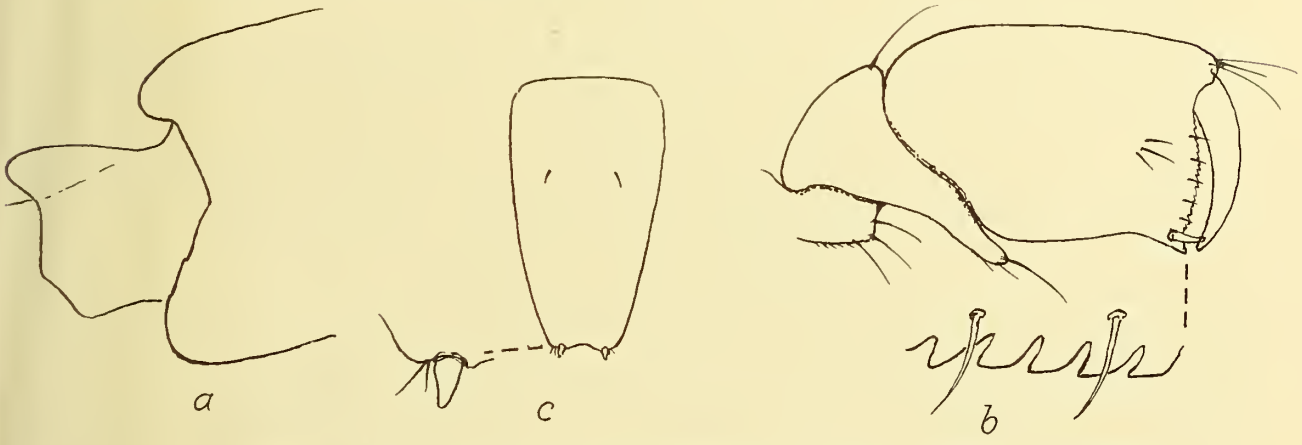
Holmes, 1908 (*l. c.*), p. 503, fig. 13.
Stephensen, 1923 (Dan. Ingolf Exp. iii), p. 60, fig. 5.

Occurrence :

St. 131 (day, 1500 metres). Southern Arabian Sea. 1 immat. ♀ 7·5 mm.



Text-fig. 2.—*Microlysias indica* n. sp. *a*, Profile of epistome and upper lip. *b*, Distal joints of gnathopod 1. *c*, Telson. *d*, Profile of epistome and upper lip of *M. xenokeras* Stebb. (Plettenberg Bay, S. Africa) for comparison.



Text-fig. 3.—*Koroga megalops* Holmes. *a*, Pleon segments 3 and 4. *b*, Hand of gnathopod 1, with palmar margin further enlarged. *c*, Telson.

Remarks.—An unexpected and noteworthy capture. Although Stephensen assigned his specimen to Holmes' species with a query, he evidently did this more on geographical than on morphological reasons, for he could find only minor differences, which possibly were due to difference in size. In the present specimen I find no essential differences.

The eyes are (or have been) maroon in colour. The molar on the mandible is a long oblique ridge. The palm of the robust hand of gnathopod 1 is minutely but deeply serrate, almost castellate, the teeth being nearly square except near the defining angle, where they become narrower and more triangular. The defining angle is a small projecting point, with a strong spine above it.

Distribution.—Alaska, 350 fathoms (Holmes); S. of Iceland, 1800 metres (Stephensen).

Gen. *Thoriella* Steph.

Stephensen, 1915, p. 39.
Pirlot, 1932 (Ann. Inst. Ocean., n.s. xii), p. 20.

Remarks.—The interpretation of the maxillipedes as given by Pirlot seems to me to be perfectly correct. Curiously enough, in the present specimen the apex of the lobe representing the remains of the palp shows a suture on the one side, exactly as in Stephensen's figures.

Thoriella islandica Steph.

Stephensen, 1915, p. 39, fig. 23.

Occurrence :

St. 76. Gulf of Oman. 1 immat. ♀ 18 mm. (to end of telson, 22 mm. to end of 1st uropod).

Remarks.—The only differences which I can find between this specimen and Stephensen's figures are as follows: 1st antennæ 18–19-jointed (3 + 15 or 16), 2nd antennæ 12–13-jointed, the proportions of the flagellar joints not quite the same as in Stephensen's figure; the palp of 1st maxilla apically rounded (but with the same deep serrations); no " broad mucronate spine " or rudimentary dactylus at end of 6th joint of gnathopod 2 concealed in the thick brush of setæ ; 2nd joint of peræopods 4 and 5 broader in proximal half, the hind margin being strongly convex.

Simple branchial lamellæ on segments 2–6. Brood lamellæ elongate, as in Stephensen's figure, and with a few long marginal setæ, on segments 2–5 ; the presence of a lamella on segment 6 (Pirlot, 1932, p. 21) would be unusual.

The head is deeply sunk in the 1st peræon segment; the ocelli (or pigment-granules) of the eyes are numerous, but somewhat loosely aggregated. Pale yellowish, the antennæ with a dull reddish tinge (as preserved).

With only such minor differences between this specimen and Stephensen's single specimen the specific identity of the two cannot be questioned, in spite of the great distance separating the two localities. It would seem that this most peculiar Amphipod is not only very rare, but that it has some special mode of life which renders its capture a matter of chance ; though it will certainly, sooner or later, be captured in some other part of the world.

Distribution.—61° 30′ N. 17° W. (Danish Oceanogr. Exp. " Thor ".)

Family Hyperiopsidæ.

Gen. *Hyperiopsis* G. O. Sars.

Stebbing, 1906, p. 714.
Walker, 1907 (Nat. Antarct. Exp. iii), p. 9.
Schellenberg, 1927 (Nord. Plankton. xx), p. 719.
Stephensen, 1934 (Tromsö Mus. Aarsheft. liii, 3), p. 4.
Pirlot, 1934, p. 167.

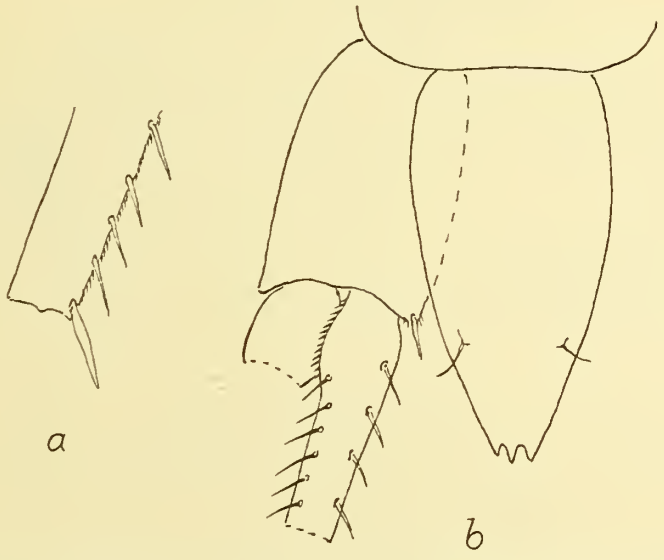
Hyperiopsis tridentata n. sp. (Text-fig. 4.)

Occurrence :

St. 61 (day, 1702 metres wire out). North Arabian Sea. 1 immat. ♀ 8 mm.

Description.—Seventh peræon segment not dorsally gibbose. Side-plates 1–4 deeper than long, more like those of *vøringii* than those of *gibbosa*. First pleon segment dorsally with basal gibbosity followed by a depression (as in Stephensen, *l. c.*, 1934, fig. 4 ; Ep. 1–3 + uros. segm. 1). Postero-inferior corner of pleon segment 1 rounded, of segments 2 and 3 quadrate with a minute point. Telson slightly longer than the half of last (6th) pleon segment, ovate-lanceolate, with tridentate apex, and a small seta (apparently arising from a minute tubercle) on each side at about $\frac{2}{3}$ the length.

No peculiarities in the antennæ. The mouth-parts were not dissected, but examined *in situ*, and apparently agree with the descriptions of Stephensen and Pirlot (1st maxillæ asymmetrical).



Text-fig. 4.—*Hyperiopsis tridentata* n. sp. *a*, Distal portion of peduncle of uropod 1. *b*, Telson and uropod 3.

Gnathopods 1 and 2 and peræopod 1 not differing from those of *vøringii* ; 4th joint of peræopod 1 resembles Stephensen's figure (*l. c.*, 1934) of this joint in *vøringii* (not Pirlot's figure of that of *gibbosa*), but is even slightly more robust, with a slightly larger projecting lobe at upper apex.

Large simple branchiæ on segments 2–7. Slender narrow oostegites (without marginal setæ) on segments 2–5.

Uropod 1, peduncle extends to base of telson, inner margin with long spaced spines, and very minute close-set spinules ; rami slender, only slightly shorter than the peduncle.

Uropod 2, only a small basal portion of the peduncle on both sides remains, but the inner margin bears close-set spinules as in uropod 1.

Uropod 3, peduncle shorter than telson and consequently much stouter than in any of the other species ; there is one spine and a few minute spinules on inner apex, but inner and outer margins are unarmed ; rami incomplete, but the inner ramus is at least as long as peduncle, with spaced spines on both margins ; a slight swelling on outer margin proximally, with a series of minute close-set spinules.

Remarks.—The outstanding features of this specimen are the telson and 3rd uropods. Although there are certain points of resemblance to the Arctic *vøringii* (*e. g.* 4th joint of peræopod 1), the telson shows an approximation to that of *gibbosa* from the East Indies. The 3rd uropods are very different from those of any of the other three species of the genus.

Family Stegocephalidæ.

Gen. *Parandania* Stebb.

Stebbing, 1906, p. 95.

Parandania boecki (Stebb.).

Walker, 1909, p. 330.
Schellenberg, 1926*a*, p. 223, fig. 28*c*.
Barnard, 1932, p. 77, fig. 35.

Occurrence :

St. 172. Central Arabian Sea. 1 immat. 14·5 mm.

Remarks.—Pleon segment 3 and postero-inferior angle of 2nd joint of peræopod 5 not so sharp as figured for the " Discovery " specimen, and 6th joints of peræopods 3 and 4 not elongate.

Recorded Localities in Indian Ocean.—Seychelles (Walker), 30° S. 87° 50′ E. and 4°–6° S. 73° E. (Schellenberg).

Distribution.—Atlantic ; South Africa.

Family Ampeliscidæ.

Gen. *Ampelisca* Kröyer.

Barnard, 1916, p. 132, and 1925, p. 335.
Schellenberg, 1925, p. 120.

Remarks.—The number of specimens of this genus in the present collection is not great, and except that the specimens identified as *cyclops* undoubtedly belong to Walker's species, and that *chevreuxi* is probably a synonym of *zamboangœ*, I am not at all satisfied that the present identifications with previously known species are correct.*

Ampelisca brevicornis (Costa).

Sars, 1891, p. 169, pl. 59, fig. 1 (*lævigata*).
Walker, 1904, p. 253.
Stebbing, 1906, p. 100.
Chevreux & Fage, 1925, p. 78, fig. 69.
Schellenberg, 1925, p. 130, fig. 9 (with vars.) ; and 1928, p. 634.
Pirlot, 1936, p. 277.

Occurrence :

St. 179 (310 metres). Gulf of Aden. 1 ovig. ♀ 8 mm.

Remarks.—In the form of the hind margin of pleon segment 3, this specimen agrees with Schellenberg's var. *intermedia*.

Recorded Localities in Indian Ocean.—Ceylon (Walker), Bagamoyo (Schellenberg var. *intermedia*), Suez (Schellenberg).

* Since this was written Pirlot (1936) has expressed the same opinion regarding *chevreuxi*.

Distribution.—N. Atlantic; Mediterranean, west, south and east coasts of Africa; Java; Japan.

Ampelisca tenuicornis Lilj.

Sars, 1891, p. 167, pl. 58, fig. 1.
Chevreux & Fage, 1925, p. 83, fig. 75.
Schellenberg, 1925, p. 122.

Occurrence:

St. MB II C. South Arabian coast. 4 specimens 4–5·5 mm.

St. Extra. South Arabian coast. 1 specimen 4·5 mm.

Remarks.—Pleon segments 4 and 5 both with rounded medio-dorsal keels. Postero-inferior angle of pleon segment 3 rounded-quadrate.

Distribution.—Western Europe and Africa to Senegal; Mediterranean.

Ampelisca zamboangæ Stebb.

Stebbing, 1888, p. 1057, pl. 106.
Walker, 1904, p. 254, pl. 3, fig. 15 (*chevreuxi*).
Pirlot, 1936, p. 280.

Occurrence:

St. 10. Red Sea. 2 specimens 6 mm.

St. B. Red Sea. 1 ovig. ♀ 10 mm.

Remarks.—First antennæ extending beyond end of peduncle of 2nd antennæ. The bevelling off of the distal third of the front margin of 3rd joint of peræopod 5 is certainly very noticeable, but is scarcely a specific character as claimed by Walker (see Stebbing's figure).

This species is very closely allied to the European and Mediterranean *typica* (Bate), but differs in the relative lengths of the 6th and 7th joints of peræopod 5, and of the penultimate and ultimate peduncular joints of 2nd antennæ—characters which appear to be somewhat inconstant.

Recorded Locality in Indian Ocean.—Ceylon (Walker, *chevreuxi*).

Distribution.—Philippine Islands; East Indies.

Ampelisca cyclops Wlkr.

Walker, 1904, p. 253, pl. 2, fig. 14.
Pirlot, 1936, p. 280.

Occurrence:

St. 74. Gulf of Oman. 2 ♀♀ 12 mm., 2 juv. 6–7 mm.

Remarks.—There is only a single lens on each side of the head at the apex; in the present specimens no red pigment surrounding the lenses. First antennæ extending to just beyond end of 4th joint of peduncle of 2nd antennæ, which is slightly longer than 5th joint; 2nd antennæ reaching to about middle of pleon. Mandibular palp slender, as described by Walker, the 2nd joint slightly longer than the 3rd (Walker's figure shows a 4-jointed palp due to the accidental division of the 2nd joint by a cross-line). Seventh joint of peræopods 1 and 2 twice (in juv.) or almost twice the combined lengths of 5th and 6th joints. Third joint of peræopod 5 distinctly longer than 4th. Telson with lateral margins evenly converging to the apex. Walker does not give the size of his specimens.

Recorded Locality in Indian Ocean.—Ceylon.

Distribution.—East Indies.

Ampelisca cf. *abyssicola* Stebb.

Stebbing, 1888, p. 1047, pl. 104.
„ 1906, p. 104.

Occurrence :

St. 105. Zanzibar area. 1 ♂ mutilated, 1 ♀ with developing brood-plates, 17 mm.

Description.—Two corneal lenses on each side of head. Postero-inferior angle of pleon segment 3 quadrate, with small point. Pleon segment 4 medio-dorsally keeled. Side-plate 4 with the same obtuse angle between lower and hind margins as in the " Challenger " figure, but the lower margin distinctly shorter than the hind margin, instead of *vice versâ*.

Second joint of mandibular palp moderately laminar.

First antenna equal to head plus peræon segments 1–3, 2nd joint twice length of 1st, flagellum *ca.* 14-jointed. Second antennæ missing.

Peræopods 1, 2, 4th joint not apically lobed, 7th equal to, or slightly longer than, the 6th plus twice the length of 5th.

Peræopod 5 as in *abyssicola*; 2nd joint with the plumose setæ continued round on to margin opposite 3rd and 4th joints (but not so definitely as in *Byblis*); 3rd and 4th joints broader than long; 3rd shorter than 4th, 5th equal to 3rd plus 4th, and almost as broad as these joints, 6th shorter and narrower than 5th (but longer than 4th), oval, 7th subequal to 6th, narrow-lanceolate.

Remarks.—There is considerable similarity between these specimens and the " Challenger " species, which was caught in the West Indies at 390 fathoms, but I do not regard the identification as absolutely certain.

Ampelisca cf. *daleyi* Giles.

Giles, 1890, p. 66, pl. 2, fig. 3.
Stebbing, 1906, p. 111.
Not *Byblis daleyi*, Pirlot, 1936, p. 284.

Occurrence :

St. 157. Maldives. 1 ♀ with embryos 5·5 mm.

Description.—Two rather large corneal lenses on each side of head. Postero-inferior angle of pleon segment 3 quadrate, and pleon segment 4 dorsally keeled (as in *æquicornis* or *anomala*, Sars, pl. 62).

Mandibular palp rather slender. First antenna extending to $\frac{2}{3}$ length of 4th joint of antenna 2, which is equal to length of head plus peræon segments 1 and 2 ; 5th joint and flagellum broken off.

Peræopods 1, 2, 4th joint not apically lobed, 7th equal to 5th plus 6th.

Peræopod 5, 2nd joint shaped as in *zamboangæ*; lobe extending to end of 3rd joint, which is a little shorter than 4th, which is subequal to 5th; 6th slightly longer than 5th, oval, 7th shorter than 6th.

Remarks.—While the 4th peduncular joint of antenna 2 is unusually long, as in *daleyi*, the 5th peræopod does not agree with that of the latter species, which closely resembles in the shape of the 2nd joint a species of *Byblis*.

Stebbing regarded *daleyi* as insufficiently described, but two of the alleged peculiarities in Giles' *figure* may, I think, be explained. The front part of the 2nd joint of peræopod

3 is filled with muscles, while the hind, more or less lobed part is clear, and the junction of the two parts is indicated by a shallow indent on the hind margin ; a glance at some of the figures in Sars, or Stebbing's " Challenger " report, will show how easy it would be for an artist to draw a line connecting the anterior corner of side-plate 5 with the indent on the hind margin of 2nd joint of peræopod 3, following the demarcation of the muscles, and thus produce the anomalous side-plate 5 with " hind border notched ". The elongate 7th joints on peræopods 3 and 4 are also anomalous, and probably some of the long setæ on the apex of the 6th joint were stuck together, giving the artist the impression of a joint. I am aware that Giles drew his own figures, but lithography was not always to be trusted.

A. daleyi was originally found off Madras, and it should not be difficult to rediscover the species and determine its identity.

Gen. *Byblis* Boeck.

Barnard, 1916, p. 139.
Pirlot, 1936, p. 282.

Byblis lepta (Giles).

Giles, 1888, p. 223, pls. 8, 9.

Occurrence :

St. 45. South Arabian coast. 1 specimen 5 mm.

St. 74. Gulf of Oman. 1 specimen 8 mm.

St. 164. Maldives. 3 specimens 5–6 mm.

Remarks.—It is unfortunate that all the specimens are somewhat mutilated. They are, however, easily identified as Giles' species by the dark brown pigment surrounding the large corneal lenses.

Two of the specimens (St. 164) show the elongate 2nd peræopod (one of these is a ♀), and both of them have elongate pleated branchiæ. One other specimen from St. 164, and the one from St. 45, have simple rather thick sac-like branchiæ, while the one from St. 74 has similar (not elongate) branchiæ with a few pleats on each side.

The species has not been recorded since Giles' time, but the present specimens scarcely lend themselves for the purpose of refiguring.

Recorded Locality in Indian Ocean.—Bay of Bengal, 107 fathoms.

Family Amphilochidæ.

Gen. *Amphilochus* Bate.

Stebbing, 1906, pp. 149, 723.

Amphilochus neapolitanus Della Valle.

Walker, 1904, p. 255 (?).
Chevreux & Fage, 1925, p. 112, figs. 106–108.

Occurrence :

St. 45. South Arabian coast. 1 ♂ 3·75 mm.

Remarks.—Mandibular molar weak. Process of 5th joint of gnathopod 2 extending to palm, which is nearly transverse.

Walker recorded a young specimen with some doubt as this species. Chilton (1921, p. 524, 1923, p. 83, 1925, p. 533) has recorded the Chilka Lake and Talé Sap specimens as *brunneus* because the process of 5th joint of gnathopod 2 did not reach the palm. Moreover he said the specimens from both localities had well-developed mandibular molars, which would place them in the genus *Gitanopsis*. In my opinion the Chilka Lake, Talé Sap and Australian specimens should be re-examined, as Chilton was inclined to unite several species which other authors kept separate (*e. g.* the South African *Gitanopsis pusilla* was made a synonym of *A. neapolitanus*, with which synonymy neither Schellenberg nor myself agree).

Recorded Locality in Indian Ocean.—Ceylon.

Distribution.—North Sea; Mediterranean; Canaries; Sahara coast.

Family Leucothoidæ.

Gen. *Leucothoë* Leach.

Barnard, 1925, p. 342.

Leucothoë spinicarpa (Abildg.).

Walker, 1904, p. 258, 1905, p. 925, and 1909, p. 331.
Gravely, 1927, p. 123.
Schellenberg, 1928, p. 687.

Occurrence:

St. 9. Red Sea. 1 ♂ 9 mm.

St. 10. Red Sea. 2 ♂♂ 8–9 mm., 1 ovig. ♀ (mutilated), 13 immat. and juv. 3–5·5 mm.

St. B. Red Sea. 3 specimens 4, 5 and 7 mm.

St. 45. South Arabian coast. 2 ♂♂ 9·5 and 10·5 mm.

St. 111. Zanzibar area. 1 specimen 5·5 mm.

St. 112. Zanzibar area. 1 specimen 6·5 mm.

Recorded Localities in Indian Ocean.—Ceylon, Maldives and Laccadives, Seychelles, Wasin (B.E.A.), Suakim (Walker); Red Sea (Spandl).

Distribution.—Cosmopolitan.

Leucothoë furina (Sav.).

Walker, 1904, p. 258, pl. 3, fig. 17; 1905, p. 925, and 1909, p. 331 (*hornelli*).
Chevreux, 1907, p. 470 (*hornelli*).
Schellenberg, 1928, p. 635.

Occurrence:

St. 53: South Arabian coast. 1 ♂ 8 mm.

Recorded Localities in Indian Ocean.—Ceylon, Maldives, Red Sea (Walker); Red Sea (Spandl); Suez (Schellenberg).

Distribution.—Gambier Archipelago (Chevreux); East Indies and Australia (Schellenberg, var. *indica*).

Gen. *Leucothoëlla* Schell.

Schellenberg, 1928, p. 638.

Leucothoëlla bannwarthi Schell.

Schellenberg, 1928, p. 638, fig. 199.

Occurrence :

St. 10. Red Sea. 3 specimens 3, 3·5 and 5 mm.

Recorded Localities in Indian Ocean.—Suez and Toussoum (Schellenberg).

Family Stenothoidæ.

Gen. *Stenothoë* Dana.

Stebbing, 1906, pp. 192, 725.

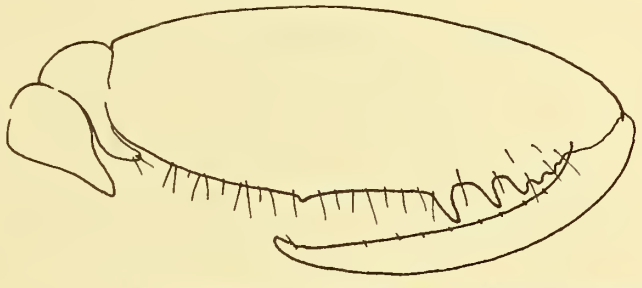
Stenothoë antennulariæ Della Valle. (Text-fig. 5.)

Della Valle, 1893, p. 565, pl. 30, figs. 1–18.
Walker, 1897 (J. Linn. Soc. Lond. xxvi), p. 229, pl. 18, fig. 3 (*crassicornis*).
Stebbing, 1906, p. 195.

Occurrence :

St. 45. South Arabian coast. 1 ♂ 2·5 mm.

Remarks.—This specimen has the curious strong bend at the base of 2nd joint of gnathopod 1 characteristic of this species. The hand of gnathopod 2 is more elongate-oval than any of those in Della Valle's and Walker's figures ; and this specimen appears



Text-fig. 5.—*Stenothoë antennulariæ* Della Valle. Hand of gnathopod 2, ♂.

to be the fully adult form of the ♂. Peduncle of uropod 3 subequal to the ramus, the 1st and 2nd joints of which are subequal. Telson with 3 spinules on each lateral margin. The discovery of this species in the Indian Ocean is interesting.

Distribution.—Gulf of Naples (Della Valle) ; Irish Sea (Walker).

Stenothoë gallensis Wlkr.

Walker, 1904, p. 261, pl. 3, fig. 19, and 1909, p. 331.
Barnard, 1916, p. 154.
Schellenberg, 1928, p. 640.
Chevreux, 1907, p. 471, figs. 1–3 (*crenulata*).
Shoemaker, 1935, p. 237, fig. 2 (*crenulata*).

Occurrence :

St. 10. Red Sea. 2 immature 2 mm.

Remarks.—The specimens are probably this species. They are dark maroon in colour. Gravely (1927, p. 123) records specimens of *valida* (identified by Chilton) from Ceylon as being " almost black ".

Recorded Localities in Indian Ocean.—Ceylon, Seychelles, Zanzibar, Red Sea, (Walker); Dar-es-Salaam (Schellenberg).

Distribution.—South Africa; Gambier Archipelago (Chevreux); Porto Rico (Shoemaker).

Family Colomastigidæ.

Gen. *Colomastix* Grube.

Barnard, 1932, p. 114.

Colomastix pusilla Grube.

Kossmann, 1880, p. 136 (*hamifera*).
Walker, 1904, p. 299, and 1909, p. 332 (*crassimanus*).
Chilton, 1925, p. 533.
Schellenberg, 1928, p. 687, footnote.

Occurrence :

St. 10. Red Sea. 1 ♀ 2 mm.

Recorded Localities in Indian Ocean.—Red Sea (Kossmann, Spandl, Walker); Suez (Schellenberg); Ceylon (Walker); Perak (Chilton).

Distribution.—North Atlantic; Mediterranean.

Family Acanthonotozomatidæ.

Gen. *Iphimedia* Rathke.

Barnard, 1932, p. 118.

Iphimedia gladiolus n. sp. (Text-figs. 6 and 7.)

Occurrence :

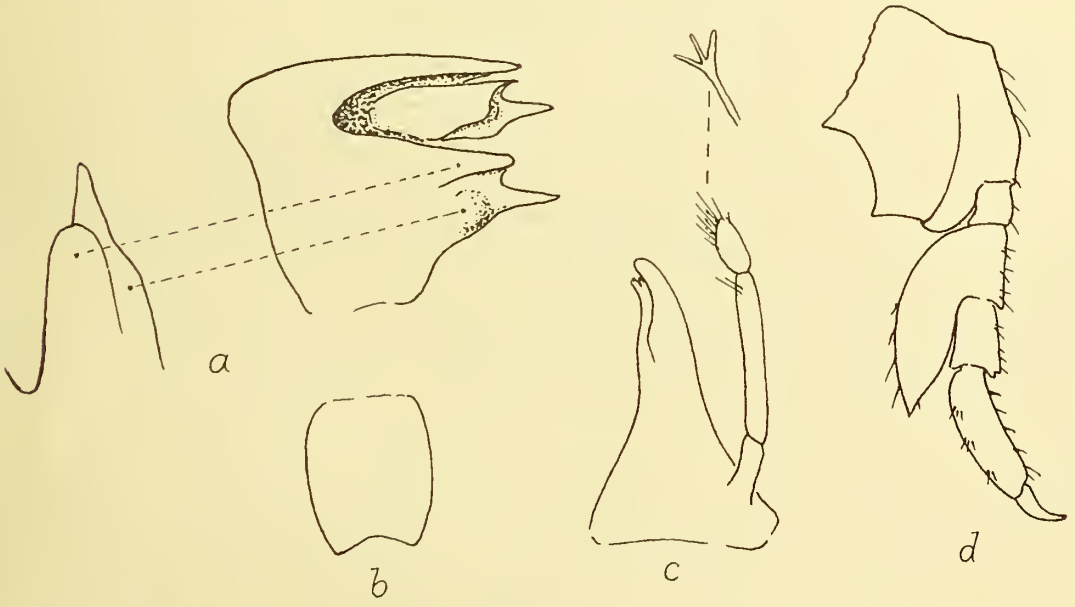
St. 45. South Arabian coast. 1 ♀ 7 mm.

Description.—Rostrum broadly triangular, slightly longer than basal width, not curved downwards. Lateral angle of head with two teeth, the upper in dorsal view rounded, the lower conical and acute. Eyes not traceable. Peræon segments 1 and 7 longest, 2–6 short, especially 2. Postero-inferior angles of segments 5–7 subacute or acute. Side-plates 1–4 acute below, 5–7 with postero-inferior angles acute. Peræon segment 7 and pleon segments 1–3 each with a pair of dorsal teeth and a medio-dorsal keel. Postero-inferior angles of pleon segments 1 and 2 subacute, of 3 acute, each segment with a tooth on hind margin. Pleon segment 4 with medio-dorsal triangular keel. Telson scarcely half as long again as broad, apex feebly emarginate.

First antennæ, 1st joint with an apical dorsal tooth, and a larger one on inner apical margin, the rest of the joints missing. Second antennæ missing. Epistome with feeble median boss. Upper lip feebly incised. Mandible slender on broad triangular base,

apically subacute, secondary cutting plate in left mandible only, palp slender, 3rd joint with some of the setæ trifid. Palp of 1st maxilla extending to end of outer plate (in both the apical setæ and spines are not reckoned). Palp of maxilliped slender.

Text-fig. 6.—*Iphimedia gladiolus* n. sp. Peræon segments 5–7, with 2nd joint of peræopods 3–5 respectively, and pleon segments 1–3 with profile of segments 4–6 and telson.



Text-fig. 7.—*Iphimedia gladiolus* n. sp. *a*, Lateral view of head and basal joint of 1st antenna, with dorsal view of the right antero-lateral angle of head. *b*, Telson. *c*, Mandible. *d*, Peræopod 5.

Gnathopod 1, 2nd joint curved, 6th slightly shorter than 5th. Gnathopod 2, 6th joint equal in length to the lower margin of 5th (but shorter if the upper margin of the latter is measured), its apex rounded. Peræopods 1 and 2 stout, anterior projection of 4th joint reaching to middle of 5th. Peræopods 3–5 stout; 2nd joint with 2 teeth on hind margin, the lower one in peræopod 3 very feeble; posterior process of 4th joint strongly

developed, extending in peræopods 3 and 4 to $\frac{1}{4}$, in peræopod 5 to $\frac{1}{3}$ length of 6th joint. Uropods not strongly spinose.

Remarks.—A species with a strong resemblance to *Panoplœa eblanœ*, but with the additional medio-dorsal keel on peræon segment 7 which the Mediterranean species lacks. The peræopods are much more robust in the present species, the specific name alluding to the appearance of the 4th joint of peræopods 3–5.

The palp of 1st maxilla appears to be intermediate between that of *Iphimedia*, where it exceeds the outer lobe, and that of *Panoplœa*, where it is feebly developed and does not reach the apex of the outer lobe. Further study must decide into which of these two genera the present species should fall; *Iphimedia* is here chosen as being the older genus.

Schellenberg (1928, p. 643) has recorded a specimen of this genus from the Suez Canal, which he identified, in spite of certain differences, with the Australian *discreta* Stebb. (1910, p. 586, pl. 49). The present species differs from *discreta* and from another Australian species, *ambigua* Hasw., in the additional medio-dorsal keel on four segments of the body.

Family Synopiidæ.

Gen. *Synopia* Dana.

Synopia ultramarina Dana.

Walker, 1909, p. 332 (*schéeleana*).
Spandl, 1924, p. 47, fig. 17*h*.
Schellenberg, 1926, p. 341, fig. 49.
Barnard, 1930, p. 367, and 1931, p. 122.

Occurrence:

St. 61 (night, surface). Northern Arabian Sea. 29 ♂♂ 3–4 mm., 43 ♀♀, some ovig. 3–3·5 mm.

Remarks.—A few of the specimens are ensconced in Salps in such a way as to indicate that they have taken up this abode of their own accord, and have not merely been pressed into the Salps in the tow-net.

Recorded Localities in Indian Ocean.—Seychelles (Walker); Red Sea (Spandl).

Distribution.—Tropical Atlantic, Indo-Pacific.

Family Œdicerotidæ.

Gen. *Œdiceroides Stebb.*

Pirlot, 1932, p. 87.
Barnard, 1932, p. 140 (references).

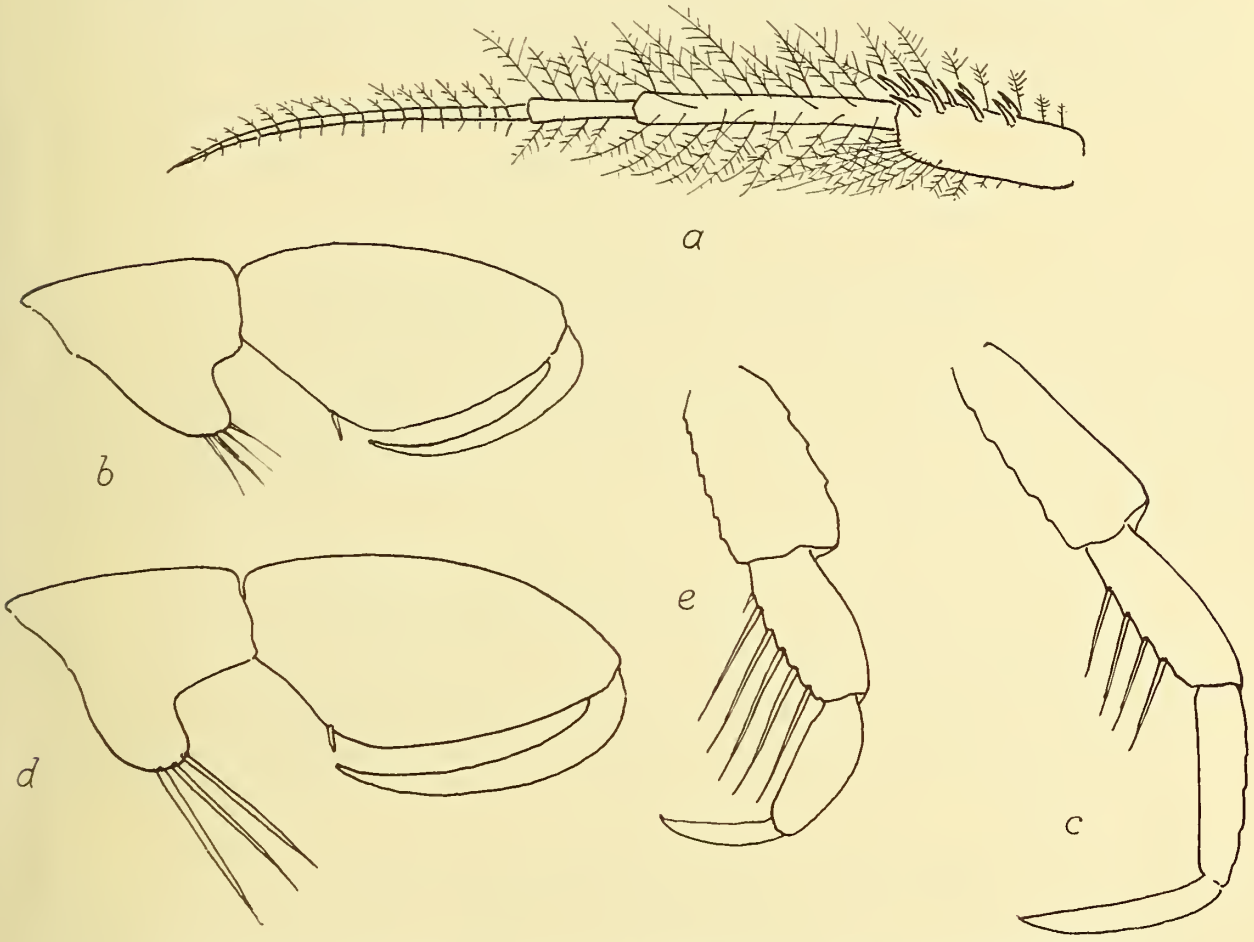
Œdiceroides antennatus n. sp. (Text-fig. 8, *a*, *b*, *c*.)

Occurrence:

St. 119. Zanzibar area. 2 ♀♀ (1 ovig.) 19 and 20 mm.

Description.—Very close to *weberi* Pirlot from the East Indies. Integument smooth and glabrous. Rostrum as in *weberi*, its medio-dorsal keel extending nearly to hind margin of head. Eyes or ocular pigment not traceable. Antero-lateral angle of head truncate. First antenna extending to middle of 5th joint of peduncle of 2nd antenna, *2nd joint longer than 1st*, the latter with strong spines on upper margin, flagellum *ca.* 19-jointed. Second

antenna with 5th peduncular joint shorter and more slender than 4th. Third joint of mandibular palp shorter than 2nd; triturating surface of molar directed inwards, not obliquely towards base of mandible. Side-plate 4 feebly excavate on hind margin, as in *cinderella* and *weberi*. Peræopods as in *weberi*, but distal joints of peræopods 1 and 2 more elongate; 4th joint in peræopods 3 and 4 well expanded. Branchiæ simple.



Text-fig. 8.—*Œdiceroides antennatus* n. sp. *a*, 1st antenna. *b*, *c*, Distal joints of gnathopod 1 and peræopod 2 respectively. *Œdiceroides zanzibaricus* n. sp. *d*, *e*, Distal joints of gnathopod 1 and peræopod 2 respectively.

Remarks.—The spines on the 1st joint of antenna 1 are not distinctive; they occur in the South African specimens assigned to *cinderella* (Barnard, 1916, p. 162). The length of the 2nd joint, however, is distinctive, and separates these specimens from any of the described species.

Œdiceroides zanzibaricus n. sp. (Text-fig. 8, *d*, *e*.)

Occurrence:

St. 120. Zanzibar area. 1 ovig. ♀ 21 mm.

Description.—In comparison with *cinderella*, *weberi* and *antennatus*, the following points are to be noted: Integument smooth and glabrous. Rostrum more strongly deflexed than in *antennatus*, its dorsal keel less conspicuous and not continued so far towards back of head. Eyes or ocular pigment not traceable. Antenna 1 not strongly

plumose, 1st joint without spines, 2nd joint slightly shorter than 1st, 3rd slightly shorter than 2nd, flagellum *ca.* 25-jointed. Antenna 2 missing. Third joint of mandibular palp shorter than 2nd, triturating surface of molar not oblique. Gnathopods 1 and 2, 5th joint with a noticeably longer " neck " between the lower lobe and the junction with 6th joint; lobe with strong elongate spines, 6th with greatest breadth slightly before the middle. Peræopods 1 and 2, especially 2, with 4th–6th joints stout, 4th particularly so, 5th with very long spines on lower margin. Side-plate 4 feebly excavate on hind margin. Other peræopods as in *antennatus*. Branchiæ simple.

Family Pleustidæ.

Gen. *Sympleustes* Stebb.

Chevreux, 1900, p. 73 (*Dautzenbergia*).
Stebbing, 1906, p. 317, and pp. xxviii, 728 (*Dautzenbergia*).
Sexton, 1909 (Proc. Zool. Soc. Lond.), p. 857.

Remarks.—Sexton thinks there is not enough justification for the separate genus *Dautzenbergia*. Chevreux (1920, ' Bull. Mus. d'Hist. Nat. Paris ', p. 8) seems to have adopted the same view in describing *dentatus* n. sp. (Canary Islands) as a species of *Sympleustes*. This species also has a cleft telson, and in fact is exceedingly close to *grandimanus*, if not actually conspecific.

Sympleustes (*Dautzenbergia*) *grandimanus* (Chevr.).

Chevreux, 1887 (Bull. Soc. Zool. Fr. xii), p. 570.
,, 1900, p. 73, pl. 10, fig. 1 (♀).
Walker, 1897 (J. Linn. Soc. Lond. xxvi), p. 230, pl. 18, fig. 4 (♂) (*Parapleustes megacheir*).
Stebbing, 1906, pp. xxviii, 317, 728.
Sexton, 1909 (Proc. Zool. Soc. Lond.), p. 857, pl. 80, figs. 8–32, and pp. 849, 850 (sex and age variations).
,, 1911 (J. Mar. Biol. Assoc. Plymouth, ix), p. 209.

Occurrence :

St. 54. South Arabian coast. 1 immature ♀ 6·5 mm.

Remarks.—The telson just reaches to end of peduncle of uropod 3. Lower margin of hand of gnathopod 1 regularly convex, without palmar angle. Palm of gnathopod 2 regularly but very minutely crenulate; near the finger-hinge two very low squarish projections separated by a minute notch.

Distribution.—Atlantic : Off Cape Finisterre, 510 metres (Chevreux), S.W. of Ireland, 750 fathoms (Walker), Bay of Biscay (Sexton).

Family Eusiridæ.

Gen. *Eusiropsis* Stebb.

Stebbing, 1906, p. 343.

Eusiropsis riisei Stebb.

Stebbing, 1897, p. 39, pls. 13, 14, and 1906, p. 343, figs. 80, 81.
Walker, 1909, p. 334.
Schellenberg, 1926, p. 351.
Barnard, 1932, p. 387, fig. 48.
Pirlot, 1934, p. 215.

Occurrence :

St. 172. Central Arabian Sea. 1 ♂ 10 mm.

Recorded Locality in Indian Ocean.—Seychelles (Walker).

Distribution.—Atlantic, East Indies (Pirlot).

Family Gammaridæ.

Gen. *Melita* Leach.

Stebbing, 1906, pp. 421, 732.

Melita fresnelii (Aud.).

Giles, 1890, p. 64, pl. 2, fig. 1 (*cotesi*).
Walker, 1904, p. 270, pl. 4, fig. 28 (*anisochir*).
,, 1909, p. 334.
Barnard, 1916, p. 189, pl. 28, fig. 32.
Schellenberg, 1928, p. 644.
Shoemaker, 1935, p. 239.

Occurrence :

St. 10. Red Sea. 2 ♀♀ 5 and 6 mm.

St. 24. Gulf of Aden. 2 ♂♂ 3·5–4·5 mm., 2 ovig. ♀♀ 3·5–4 mm., 2 immat. 3 mm.

St. 112. Zanzibar area. 1 immat. 4 mm.

Recorded Localities in Indian Ocean.—Andaman Is. (Giles) ; Ceylon, Seychelles, Wasin (B.E.A.), Suakim (Walker) ; Suez Bay (Schellenberg).

Distribution.—Western tropical Atlantic ; Egypt and Suez Canal ; East Indies ; South Africa ; Australia ; California.

Gen. *Mœra* Leach.

Stebbing, 1906, pp. 433, 732.

Mœra inæquipes (Costa).

Kossmann, 1880, p. 133 (*massavensis*).
Miers, 1884, p. 567, pl. 52, fig. D (*diversimanus*).
Walker, 1904, p. 273, pl. 5, fig. 32 (*scissimana*).
,, 1909, p. 334.
Schellenberg, 1928, p. 646.

Occurrence :

St. 10. Red Sea. 1 ♂ 4·5 mm.

St. D. Red Sea. 1 ♂, 1 ovig. ♀ 5 mm.

St. 53. South Arabian coast. 1 ♀ 5 mm.

Recorded Localities in Indian Ocean.—Red Sea (Kossmann, Spandl) ; Seychelles (Miers) ; Maldives, Seychelles, Wasin, Suez, Suakim (Walker) ; Suez (Schellenberg).

Distribution.—Bermuda ; Azores and Canaries ; Mediterranean ; South Africa ; Australasia ; Chile.

Gen. *Ceradocus* Costa.

Stebbing, 1906, p. 430.

Ceradocus rubromaculatus (Stimpson). (Text-fig. 9.)

Walker, 1904, p. 272, pl. 5, fig. 30; 1905, p. 927; 1909, p. 334.
Chevreux, 1907, p. 479, fig. 6.
Chilton, 1921*a*, p. 71, fig. 9.
Tattersall, 1922, p. 6, pl. 1, figs. 15, 16.
Schellenberg, 1925, p. 154, and 1928, p. 644.
Pirlot, 1934, p. 222.

Occurrence:

St. 10. Red Sea. 1 ♂ 6·5 mm.

Remarks.—The hand of gnathopod 2 on the right side is intermediate between Chilton's and Tattersall's figures, oval, without any defining angle, palm with two small notches between flat-topped projections. The gnathopod on the left side is much smaller, shaped as in the ♀.

Text-fig. 9.—*Ceradocus rubromaculatus* (Stimpson). Hand of gnathopod 2, ♂ (right side).

Recorded Localities in Indian Ocean.—Maldives, Ceylon, Seychelles, Wasin (B.E.A.), Red Sea (Walker); Suez (Schellenberg).

Distribution.—South Africa; East Indies; Australia; New Zealand, and Gambier Archipelago.

Gen. *Elasmopus* Costa.

Stebbing, 1906, pp. 441, 732.
Stephensen, 1932, p. 487.
Pirlot, 1936, p. 312.

Remarks.—In Stephensen's list of species *latibrachium* Wlkr., 1905, should be transferred from Group A to Group Ci, as it has paired dorsal processes on pleon segment 4.

Elasmopus subcarinatus (Hasw.).

Walker, 1904, p. 275, pl. 5, fig. 34, and 1909, p. 335.
Gravely, 1927, p. 123.
Stephensen, 1931, p. 11.
Barnard, 1935, p. 286.

Occurrence:

St. 45. South Arabian coast. 6♂♂ 6–9·5 mm., 4 ovig. ♀♀ 4·5–7 mm., 11 immature and juv. 3–6 mm.

Recorded Localities in Indian Ocean.—Ceylon and Seychelles (Walker); Ceylon (Gravely); Tuticorin Pearl Banks (Barnard).

Distribution.—East Indies; Australasia; South Africa.

Elasmopus pectenicrus Bate.

Kossmann, 1880, p. 132 (*brasiliensis* ? non Dana).
Walker, 1904, p. 277, pl. 8, fig. 34 (*serrula*), and 1909, p. 336 (*serruta*).
Barnard, 1916, p. 197, pl. 28, fig. 33.
Gravely, 1927, p. 123.
Schellenberg, 1928, p. 647.
Shoemaker, 1935, p. 238.
Pirlot, 1936, p. 312.

Occurrence :

St. 53. South Arabian coast. 1 juv. 4·5 mm.

Recorded Localities in Indian Ocean.—Red Sea (Kossmann, Spandl); Ceylon, Zanzibar, Suez (Walker); Ceylon (Gravely); Suez and Dar-es-Salaam (Schellenberg).

Distribution.—New Guinea; South Africa; East Indies; Porto Rico, W.I.

Elasmopus erythræus (Kossm.). (Text-fig. 10.)

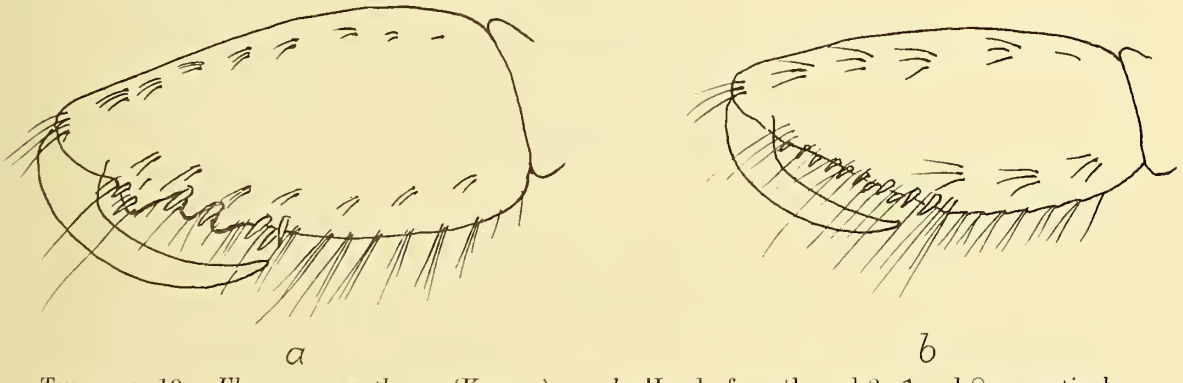
Kossmann, 1880, p. 132, pl. 14, figs. 1–8 (*Moera e.*).
Stebbing, 1906, p. 446 (" probably young of another species ").

Occurrence :

St. B. Red Sea. 1 ♂, 1 ♀ 7 mm., 1 immat. 6·5 mm., 1 juv. 4 mm.

St. 53. South Arabian Sea. 1 ♂ 6·5 mm., 1 ovig. ♀ 8 mm., 1 juv. 4·5 mm.

Description.—Accessory flagellum of 1st antenna short, 3-jointed. Mandibular palp as in *rapax* and Kossmann's figure. Peræopods 3–5, 2nd joint with a few rather widely-spaced serrations on hind margin.



Text-fig. 10.—*Elasmopus erythræus* (Kossm.). *a*, *b*, Hand of gnathopod 2, ♂ and ♀ respectively.

No segments dorsally dentate, but peræon and pleon sparsely setose, as in *carnleyi* Steph., *rapax* (*fide* Kunkel, 1910) and *sokotræ* (Walker and Scott's figure). Postero-inferior angle of pleon segment 3 quadrate with short point. Telson—in notch at apex of each lobe 2 long spines flanked on inner side by 1 shorter one, and on outer side by 1 short spine-seta, one spine-seta on lateral margin (see Kossmann's figure).

Remarks.—There are good reasons for assigning these specimens to *erythræus*. Kossmann's description I have not seen, but from tracings of the figures there seems

to be agreement in the mandibular palp, the telson, and the 2nd gnathopod. The figure of the latter seems rather sketchy, but it is not unlikely that Kossmann overlooked the two conical teeth behind the squarish tooth near the hinge, as they are somewhat obscured by the spines and the long setæ. The locality is an additional reason. The length of Kossmann's species is given by Stebbing as about 6 mm.

Recorded Locality in Indian Ocean.—Red Sea.

Family Dexaminidæ.

Gen. *Polycheria* Hasw.

Stebbing, 1906, pp. 519, 735.

Polycheria atolli Wlkr.

Walker, 1904, p. 266, pl. 4, fig. 25 (non *antarctica* Stebb.).
„ 1905, p. 926, pl. 88, figs. 1–5, and 1909, p. 337.
Barnard, 1916, p. 211 (*antarctica* non Stebb.).
„ 1930, p. 390, fig. 49*d*.
Schellenberg, 1925, p. 157, fig. 15.

Occurrence :

St. B. Red Sea. 2 specimens 3·5 and 4·5 mm.

Remarks.—It seems certain that Walker's Ceylon specimens should be assigned to this species, and not to *antarctica*. Shoemaker (1935, p. 240) records *antarctica* from St. Thomas, W.I., without apparently distinguishing *atolli* and *antarctica*.

Recorded Localities in Indian Ocean.—Ceylon, Maldives, Seychelles, and British East Africa (Walker).

Distribution.—South Africa; New Zealand.

Family Talitridæ.

Gen. *Hyale* Rathke.

Stebbing, 1906, pp. 559, 735.
Barnard, 1916, p. 229.

Hyale nigra (Hasw.).

Stebbing, 1906, p. 571.
Schellenberg, 1928, p. 659, fig. 204.

Occurrence :

St. Extra. South Arabian coast. 2 ♂♂ 5·5–6·5 mm., 2 ovig. ♀♀ 5–5·5 mm., 4 juv. 2·5–3·5 mm.

St. MB II A. South Arabian coast. 1 ♂ 6 mm.

Remarks.—These specimens are larger than previous records; Suez Canal 4–5 mm. (Schellenberg), Australia 5 mm. (Haswell). The palp of the maxilliped is robust, and has no long apical seta, thus differing from the Mediterranean *camptonyx*. The lobe on distal end of 2nd joint of 2nd gnathopod is feebly crenulate. Otherwise as in Schellenberg's description.

Recorded Locality in Indian Ocean.—Suez Canal (Schellenberg).
Distribution.—Port Jackson, Australia (Haswell).

Family Aoridæ.

Gen. *Lembos* Bate.

Stebbing, 1906, pp. 594, 737.
Barnard, 1916, p. 237.

Lembos podoceroides Wlkr.

Walker, 1904, p. 279, pl. 6, fig. 39 ; 1905, p. 929 ; and 1909, p. 338.

Occurrence :

St. 27. Gulf of Aden. 1 ovig. ♀ 6 mm. (mutilated), 1 immat. 4 mm.

St. MB II C. South Arabian coast. 1 immat. ♂ 6 mm.

St. 45. South Arabian coast. 175 ♂♂ ♀♀ (some ovig.) and juv. 3–7 (or 8) mm.

Remarks.—No epistomial spine ; no ventral spines on the sterna. The present specimens show a characteristic grey speckling on the back of the pleon, sometimes also a small black medio-dorsal dot on peræon segment 7, or segments 6 and 7.

Walker (1904, p. 280) has remarked on the striking resemblance of the hand of 1st gnathopod of the adult ♂ to that of the 2nd gnathopod of *Jassa falcata* ; but the resemblance in a *fully* adult ♂, such as is present in the John Murray collection, is even more striking than Walker's figure shows it to be, because the 6th joint is more elongate, with the front and hind margins subparallel, the latter being thus concave. Another curious resemblance between the 1st gnathopod ♂ of one species and the 2nd gnathopod of another species is found in *Lembos chelatus* Wlkr. (1904, p. 280, pl. 6, fig. 40) and *Audulla chelifera* Chevr. (1901, p. 432, figs. 56–65). Walker and Scott (1903, p. 226) are certainly correct in placing the latter genus in the *Photidæ* rather than in the *Jassidæ*.

Walker's comparison of his species with *websterii* (see Sars, 1894, pl. 194) is not justified as regards the 3rd uropods ; in *websterii* the rami are not much longer than the peduncle, whereas in *podoceroides* they are twice (or almost) as long as the peduncle.

The rami much longer than the peduncle in uropod 3, combined with the presence of a spiniform process on *both* the 5th and 6th joints in 1st gnathopod ♂, are the features on which Pearse instituted the genus *Lembopsis* (1912). The utility of this genus may be questioned. There is a notable resemblance between the *sixth* joint of 1st gnathopod ♂ of the Mexican *Lembopsis spinicarpus* Pearse and that of the not quite fully adult ♂ of the present species, but the absence of a spiniform process on the 5th joint at once distinguishes the latter.

Recorded Localities in Indian Ocean.—Ceylon, Maldives, Red Sea (Walker).

Family Photidæ.

Gen. *Photis* Kröyer.

Stebbing, 1906, pp. 605, 738.
Barnard, 1932, p. 223.

Photis longicaudata (Bate & Westw.).

Walker, 1904, p. 286, pl. 6, fig. 43, and 1909, p. 339.
Chevreux and Fage, 1925, p. 310, fig. 319.
Schellenberg, 1928, p. 662.
(*Non* Barnard, 1916 = *uncinata* Brnrd. 1932.)
(*Non* Chilton, 1921 and 1925 = *digitata* Brnrd. 1935.)
(? Chilton, Phillipp. J. Sci., xvii, p. 513, 1920.)

Occurrence :

St. MB II C. South Arabian coast. 3 ♂♂, 1 ♀ 3·5–4 mm.

St. 45. South Arabian coast. 1 ♂ 2·3 mm., 1 ♀ 3 mm., 2 juv. 2 mm.

Recorded Localities in Indian Ocean.—Ceylon, Seychelles, British East Africa (Walker) ; Suez Canal (Schellenberg).

Distribution.—N. Atlantic and Mediterranean.

Photis dolichommata Stebb.

Stebbing, 1910, p. 609, pl. 55B.
Barnard, 1916, p. 247.

Occurrence :

St. 53. South Arabian coast. 1 ♀ 5 mm. (somewhat mutilated).

Remarks.—*P. lamellifera* Schell., 1928, from Zanzibar may perhaps prove synonymous. The elongate setæ on 6th joint of peræopod 5 are shown in Stebbing's figure of *dolichommata* and are found in the South African specimens and the present one. On the other hand, the lobed 5th joint in peræopods 3 and 4 is not conspicuous in South African ♂♂.

Distribution.—New South Wales ; South Africa.

Gen. *Eurystheus* Bate.

Stebbing, 1906, pp. 610, 738.
Barnard, 1932, p. 224.

Eurystheus atlanticus (Stebb.).

Walker, 1904, p. 282, pl. 6, fig. 41 (*zeylanicus*).
,, 1905, p. 929, pl. 88, figs. 11–14, 16, 17 (*gardineri*).
,, 1909, p. 339 (*zeylanicus*) and footnote.
Stebbing, 1908, p. 86, pl. 14B.

Occurrence :

St. 10. Red Sea. 1 ♂ 5 mm., 4 ♀♀ 4·5–5 mm., 2 ovig. ♀♀ 6·5 mm.

Anchorage. South Arabian coast, 27.x.33. 10 ♂♂ 3–4 mm.

St. MB II A. South Arabian coast. 2 ♂♂ 5·5–6 mm.

St. 45. South Arabian coast. 7 ♂♂ 4–5 mm., 2 ♀♀ 5–6 mm.

Remarks.—The ♂♂ collected at the surface by hand-net at Anchorage are smaller than the others, and the inner ramus of 3rd uropod has an apical spinule only.

Recorded Localities in Indian Ocean.—Ceylon, Maldives, Seychelles (Walker).

Distribution.—Cape Verde Is. ; South Africa.

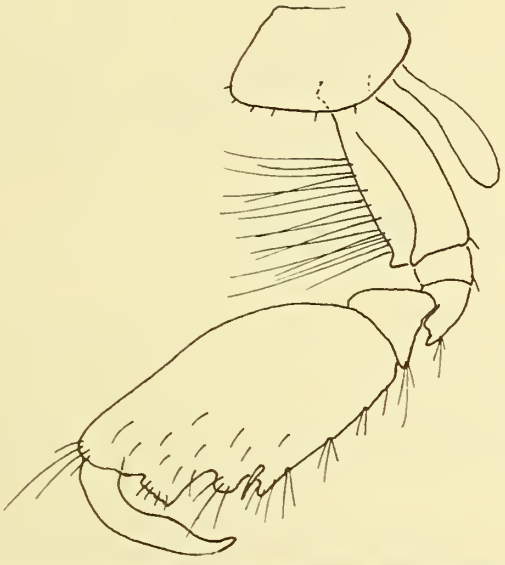
Eurystheus imminens Brnrd. (Text-fig. 11.)

Barnard, 1916, p. 250, pl. 28, fig. 12.

Occurrence :

St. 10. Red Sea. 1 ♂ 4·5 mm.

Remarks.—This specimen best fits the South African species, but seems to have a more fully developed 2nd gnathopod, although the animal is smaller in size. Both outer and inner anterior margins of 2nd joint of 2nd gnathopod end below in short triangular points, the latter more prominent (more easily observed) than the former; inner anterior margin with numerous very long simple setæ (as in the type). The 1st gnathopod fits



Text-fig. 11.—*Eurystheus imminens* Brnrd. Side-plate 2 and gnathopod 2, ♂, outer surface.

over, and externally to these setæ, into the hollowed antero-external surface of 2nd joint of 2nd gnathopod. The lower margin of 6th joint of 2nd gnathopod has fewer indents, with tufts of setæ, than in the type, and the palmar tooth nearest the hinge is squarer.

Although found together with *atlanticus*, this ♂ is recorded under the name *imminens*, and a figure is given to serve as a basis for future students to decide whether the latter name should be sunk as a synonym of *atlanticus*. The distinction in the palms of 2nd gnathopod of the two forms is this : in *atlanticus* the middle tooth is larger than that nearer the finger-hinge, but *vice versa* in *imminens*.

Distribution.—Natal coast, 27 fathoms.

Eurystheus afer (Stebb.). (Text-fig. 12.)

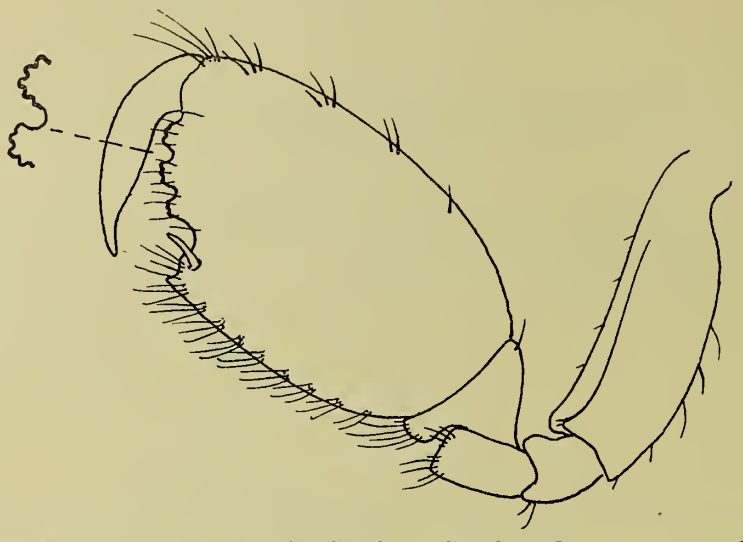
Barnard, 1916, p. 249, pl. 28, fig. 11.
Schellenberg, 1928, p. 662.

Occurrence :

St. 105. Zanzibar area. 2 ♂♂ 7·5 mm., 1 ♀ in dead *Balanus* shell, 9 mm.

St. 110. Zanzibar area. 1 ovig. ♀ 9·5 mm.

Recorded Localities in Indian Ocean.—Gulf of Suez and Bagamoyo (Schellenberg).
Distribution.—South Africa.



Text-fig. 12.—*Eurystheus afer* (Stebb.). Gnathopod 2, ♂, outer surface.

Eurystheus lophomeria n. sp. (Text-fig. 13.)

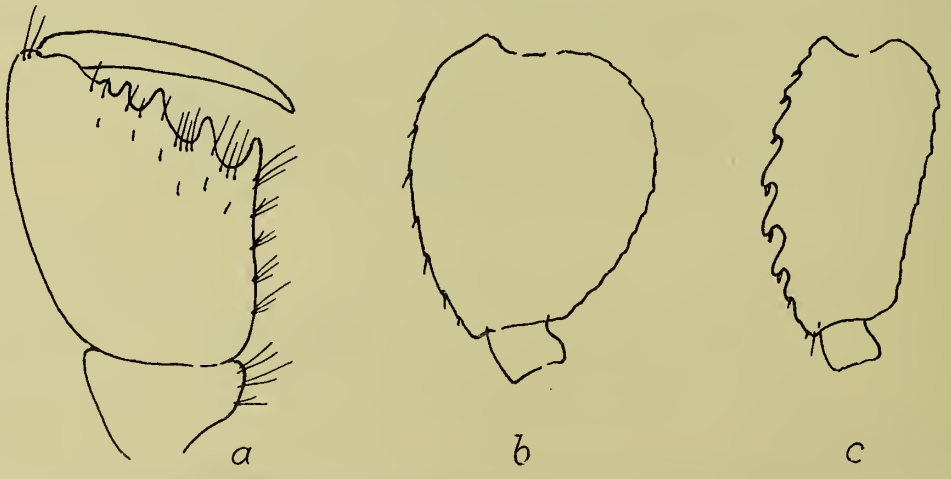
Occurrence :

St. 53. South Arabian coast. 1 ♂ 4 mm.

Description.—Ocular lobes moderately produced, subacute. Eyes rather large, oval. Side-plates rather shallow, entire. Postero-inferior angle of pleon segment 3 quadrate, with a short point; hind margin convex above the indent (cf. *thomsoni* Stebb., 1888, pl. 115). Pleon segment 4 dorsally with 3 teeth, segment 5 with 2 teeth (cf. *dentatus* Chevr., 1900, pl. 12), with a seta in the angle of each tooth.

Epistome with prominent spiniform process. Antennæ missing.

Gnathopod 1 normal. Gnathopod 2, 2nd joint channelled in front, but neither inner nor outer edge with a prominent distal lobe, 6th joint widening to the slightly oblique



Text-fig. 13.—*Eurystheus lophomeria* n. sp. *a*, Hand of gnathopod 2. *b*, 2nd joint of peræopod 3. *c*, 2nd joint of peræopod 5.

palm, which has 2 small teeth near hinge, then 2 larger ones, and a strong defining tooth, finger nearly straight.

Peræopod 3, 2nd joint broadly expanded, with spaced spinules on anterior margin, and feeble serrations on hind margin.

Peræopods 4 and 5 longer than peræopod 3, 2nd joint oblong, hind margin feebly serrate in both peræopods, anterior margin in peræopod 4 as in peræopod 3, but in peræopod 5 with a series of strong teeth, curving downwards, each bearing a spinule subapically.

Uropod 3 with well developed, subequal rami.

White with greyish speckling in places, eyes black.

Remarks.—Although the antennæ are missing, and the presence or absence of an accessory flagellum cannot be determined, the specimen has all the appearances of an *Eurystheus*. It seems to be allied to *dentatus* Chevr., 1900, and *semidentatus* Brnrd., 1916, but is distinguished by the more numerous palmar teeth in gnathopod 2, and the remarkable crest on front margin of 2nd joint (femur) of peræopod 5.

Gen. *Cheiriphotis* Wlkr.

Walker, 1904, p. 283.
Pirlot, 1934, p. 230.

Remarks.—I would suggest that the Australian *C. australis* Stebb. (1910, p. 611, pl. 54) is the same animal as that described by Haswell (1880, 'Proc. Linn. Soc. N.S.W.', iv, p. 332, pl. 20, fig. 4) as *Mœra dentifera*, which Stebbing (1906) transferred to the genus *Eurystheus*.

Cheiriphotis megacheles (Giles). (Text-fig. 14.)

Giles, 1885, p. 70, pl. 3 (*Melita m.* = ♂).
,, 1887, p. 227, pl. 8 (*Eurystheus hirsutus* = ♀).
Walker, 1904, p. 284, pl. 6, fig. 42.
Stebbing, 1910*a*, p. 461, and 1918, p. 68, pl. 12 (*walkeri*).
Barnard, 1916, p. 247 (*durbanensis*).
Schellenberg, 1926, p. 381.
Pirlot, 1934, p. 231, fig. 100 (*delloyei*).

Occurrence :

St. 53. South Arabian coast. 1 ♂ (not fully adult) 3·5 mm., 1 ovig. ♀ 5 mm.

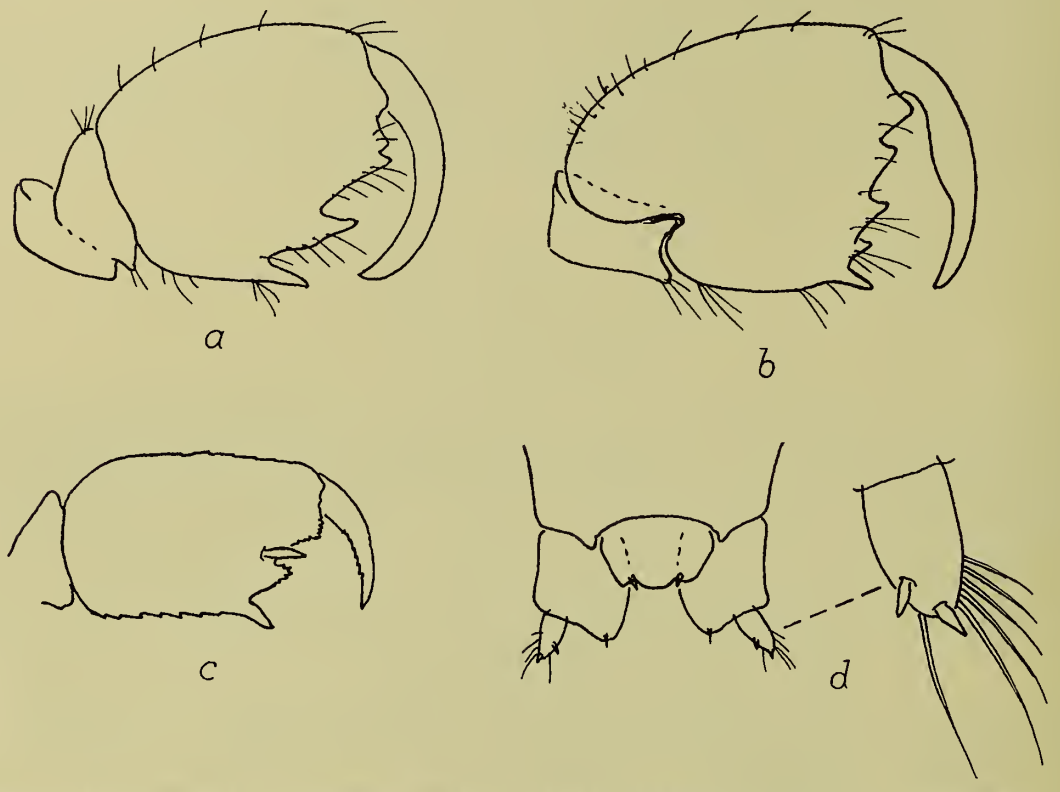
Remarks.—As regards *walkeri* Stebb., 1918, from Natal, I think there can be no doubt that it is synonymous with the Indian *megacheles*, which Stebbing (1910*a*) and Schellenberg (1926) have already recorded from South Africa. In addition to the indent in the palm of gnathopod 1, mentioned by Stebbing, there is a slight difference in the 1st peræopod, which in *walkeri* is more slender than in Walker's figure of that of *megacheles* (Stebbing's figure of gnathopod 1 is also more slender than that given by Walker).

In comparing *durbanensis* and the present specimen with Walker's and Stebbing's figures, we find that the 2nd joint of peræopod 1 is stout (only twice as long as wide) and not (or scarcely) curved (as in Stebbing's figure of *australis*). The hand of gnathopod 2 in the present specimen is obviously comparable with Walker's figure, and that of

durbanensis would seem to be an immature form, in which the 4th and 5th joints are only partly fused. When a large series of ♂♂ is available, comprising all growth-stages, I feel sure that *durbanensis* will prove synonymous. As this species has not been figured, I take this opportunity of giving a figure of the 2nd gnathopod ♂ alongside that of the John Murray specimen.

I feel constrained to make *delloyei* Pirlot also a synonym, if not of *megacheles*, at least of *durbanensis*.

Remarks on the Female.—In the present specimen the side-plates are very shallow, the 1st as figured by Walker, 1–4 setose. Gnathopod 2 very similar to Walker's figure.



Text-fig. 14.—*Cheiriphotis megacheles* (Giles). *a*, Hand of gnathopod 2, ♂ (type of *durbanensis* Brnrd.). *b*, Hand of gnathopod 2, ♂ (St. 53). *c*, Hand of gnathopod 2, ♀ (setæ omitted). *d*, Telson and 3rd uropods, ♀, with outer ramus of latter further enlarged.

Peræopods with numerous plumose setæ, especially on the 2nd–5th joints of peræopods 3–5. Uropod 3 without a trace on inner ramus, only a spinule on inner apex of peduncle.

The specimen seems to be the same as the ♀ described by Walker (1904), but as I have not seen Giles' description and figure of *hirsutus* (only Stebbing's 1906 description) I can express no opinion about the latter species. Walker seems to have had no doubt that *hirsutus* was the ♀ of *megacheles*, although in 1909 (p. 341) he says *E. monuropus* Wlkr. is distinct because Giles made no mention of the *inequality* of the rami of uropod 3. If Giles' *hirsutus* really had short but equal rami on uropod 3 there would be reason to doubt whether it should be regarded as the ♀ of *megacheles*.

E. monuropus Wlkr. (1909, p. 340, pl. 43, fig. 8) from Seychelles, British East Africa and Red Sea, has so many points of resemblance to Walker's 1904 ♀♀ of *megacheles* and to

the present specimen (shallow side-plates, etc.) that it should undoubtedly be transferred to the genus *Cheiriphotis* ; and it would not be surprising if future study shows it to be synonymous with *megacheles*.

Recorded Localities in Indian Ocean.—Bay of Bengal (Giles) ; Ceylon (Walker).

Distribution.—South Africa ; East Indies, 794 metres (*delloyei* Pirlot).

Gen. *Chevalia* Wlkr.

Walker, 1904, p. 288.
Pearse, 1912 (Proc. U.S. Nat. Mus. xliii), p. 374.

Remarks.—*C. mexicana* Pearse is very closely allied to the genotype, but is described as having side-plates 1 and 2 rounded below, instead of pointed.

Chevalia aviculæ Wlkr. (Text-fig. 15.)

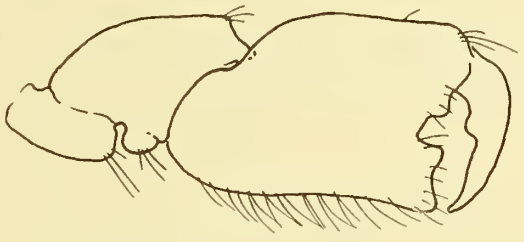
Walker, 1904, p. 288, pls. 7, 8, fig. 50, and 1909, p. 341.
Barnard, 1916, p. 252.

Occurrence :

St. 10. Red Sea. 3 ♀♀ (2 ovig.) 3–4 mm.

St. 45. South Arabian coast. 1 ♂ 4 mm., 1 ovig. ♀ 4·5 mm.

Remarks.—Flagellum of antenna 1 8-jointed, of antenna 2 6-jointed. Outer rami or uropods 1 and 2 shorter than the acutely-pointed inner rami, tipped in uropod 1 with 2–3, in uropod 2 with 3–4 spinules ; opposing margins of the rami in uropod 1 finely



Text-fig. 15.—*Chevalia aviculæ* Wlkr. Distal joints of gnathopod 2, ♂.

setulose or ctenate. Gnathopod 2 has the hand more highly developed than in Walker's specimens or the South African ones ; 6th joint with a deep notch in the transverse palm, the defining angle of which is rounded-quadrate ; finger with a small projection on inner margin opposite the palmar notch. The hand of gnathopod 2 ♀ is similar to that of ♂, but the palmar notch and dactylar projection are much less pronounced. The branchiæ in both sexes, and the brood-lamellæ in ♀, are elongate and narrow, the latter setose on the margins (see Pearse, *l. c.*, fig. 5).

Recorded Localities in Indian Ocean.—Ceylon, Seychelles (Walker).

Distribution.—South Africa.

Family Ampithoidæ.

Gen. *Ampithoë* Leach.

Stebbing, 1906, pp. 631, 738.

Ampithoë ramondi (Aud.).

Kossmann, 1880, p. 134, pl. 14, figs. 12, 13 (*erythræa*).
Chevreux, 1901, p. 418 (*vaillanti*).
Walker, 1904, p. 291 (*vaillanti*), and 290, pl. 7, fig. 46 (*intermedia*).
,, 1905, p. 391 (*intermedia*).
,, 1909, p. 341 (*intermedia*), and p. 342, pl. 43, fig. 9 (*lobata*).
Barnard, 1916, p. 253 (*vaillanti*).
Chevreux & Fage, 1925, p. 333, figs. 341, 342 (*vaillanti*).
Schellenberg, 1928, p. 665.
Barnard, 1935, p. 305.

Occurrence :

St. Extra. South Arabian coast. 2 ♂♂ 4·5 mm., 1 ovig. ♀ 5 mm.

Remarks.—There is little reason to doubt that *lobata* is synonymous. The lobes on 2nd (and 3rd) joints of the gnathopods are not characteristic, and the tertiary cutting-edge on the mandible, *in the position figured by Walker*, is merely the new mandible developing within the old. Giles (1888, p. 242, pl. 10, fig. 2) describes and figures a triple cutting-edge in *A. inda* M. Edw., based probably on erroneous observation (*cf.* Sars, 1894, pl. 206).

The position of Milne Edwards' species is uncertain, though Giles' specimens seem referable to the present species. Giles' figures show no lobes on 2nd joints of the gnathopods.

Recorded Localities in Indian Ocean.—Red Sea (Kossmann, Spandl) ; Ceylon, Maldives, Wasin, Zanzibar (Walker) ; Suez and Suez Canal (Walker, Schellenberg) ; Seychelles (Walker, Chevreux) ; Dar-es-Salaam (Schellenberg) ; Tuticorin Pearl Banks (Barnard).

Distribution.—Atlantic to Azores, Mediterranean ; South Africa ; Southern Pacific.

Ampithoë falsa Brnrd. (Text-fig. 16.)

Barnard, 1916, p. 255, pl. 28, fig. 34 (*brevipes* non Dana).
,, 1932, p. 240.

Occurrence :

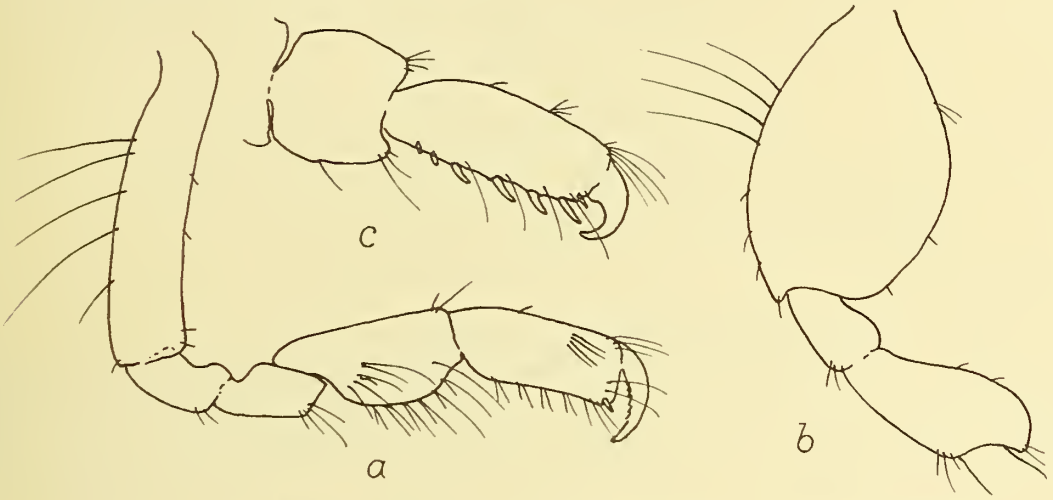
St. 22. Central Arabian Sea. 1 juv. 4 mm.

St. 31. Gulf of Aden. 1 ♂ 8 mm., 1 ♀ with embryos 7·5 mm.

Remarks.—Resembling the South African specimens in all respects. The 4th and 5th joints of peræopods 3 and 4 are very stout, the 5th joint of peræopod 3 being as broad as long.

There is a most deceptive resemblance between this species and *alluaudi* Chevr. (1901, p. 418, figs. 40–45) from the Seychelles ; but a detailed examination shows a number of differences. Both species have the same stout peræopods 3 and 4, a similar hand in gnathopod 2 ♂ (much heavier in the larger specimens of *falsa*), and comparatively slender mandibular palp. The 2nd joints of peræopods 1 and 2 are described as being strongly

dilated in *alluaudi* but no figure is given ; and the small habitus figure leaves one a little uncertain whether the 4th joints of these peræopods are as strongly lobed as in *falsa*. The mandibular palp in *falsa* is not cylindrical, but flattened ; when viewed edge-on it resembles Chevreux's figure ; when viewed at right angles, however, the joints are seen to be a little broader (as in Sars' figure of *Pleonexes*, 1894, pl. 207), the 3rd joint not quite as long as the 2nd (as in Chevreux's figure).



Text-fig. 16.—*Ampithoë falsa* Brnrd. *a*, Gnathopod 1. *b*, Proximal joints of peræopod 1. *c*, Distal joints of peræopod 3.

The outstanding differences are : the absence in *falsa* of a lobe at distal anterior end of 2nd joints of gnathopods 1 and 2 (both sexes), the rectangular shape of 6th joint of gnathopod 1 with its transverse palm (both sexes), and the shape and armature of 6th joint of peræopod 3. Gnathopod 2 in ♀ also has the hand rectangular, with transverse palm.

Chevreux remarks on the intermediate position *alluaudi* occupies between the genera *Ampithoë* and *Pleonexes*. The only real similarity to the latter genus seems to lie in the mandibular palp.

Distribution.—False Bay, South Africa.

Gen. *Grubia* Czern.

Stebbing, 1906, pp. 644, 738.
Barnard, 1916, p. 257 (references), and add Chevreux, 1907, p. 517 *Grubia filosa* (Sav.).

Grubia filosa (Sav.).

Walker & Scott, 1903, p. 226, pl. 14B, fig. 3*a–e* (*longicornis* non Kossm.).
Schellenberg, 1928, p. 666, fig. 206 (references and synonymy).
Shoemaker, 1935, p. 245, figs. 4, 5.

Occurrence :

St. MB II A. South Arabian coast. 2 ♀♀ 17–18 mm., 1 ovig. ♀ 15 mm.

Remarks.—Eyes without dark pigment. The body and peduncles of the antennæ of the ovigerous ♀ retain traces of a pale mauve coloration.

Recorded Localities in Indian Ocean.—Egypt or Red Sea (Savigny) ; Abd-el-Kuri (Walker & Scott) ; Suez and Dar-es-Salaam (Schellenberg).

Distribution.—If, as Schellenberg says, the identity of the several forms is accepted, the species ranges from the east coast of North America, through the Mediterranean and Indian Ocean to Australia. West Indies (Shoemaker).

Gen. *Sunamphitoë* Bate.

Stebbing, 1906, p. 645.

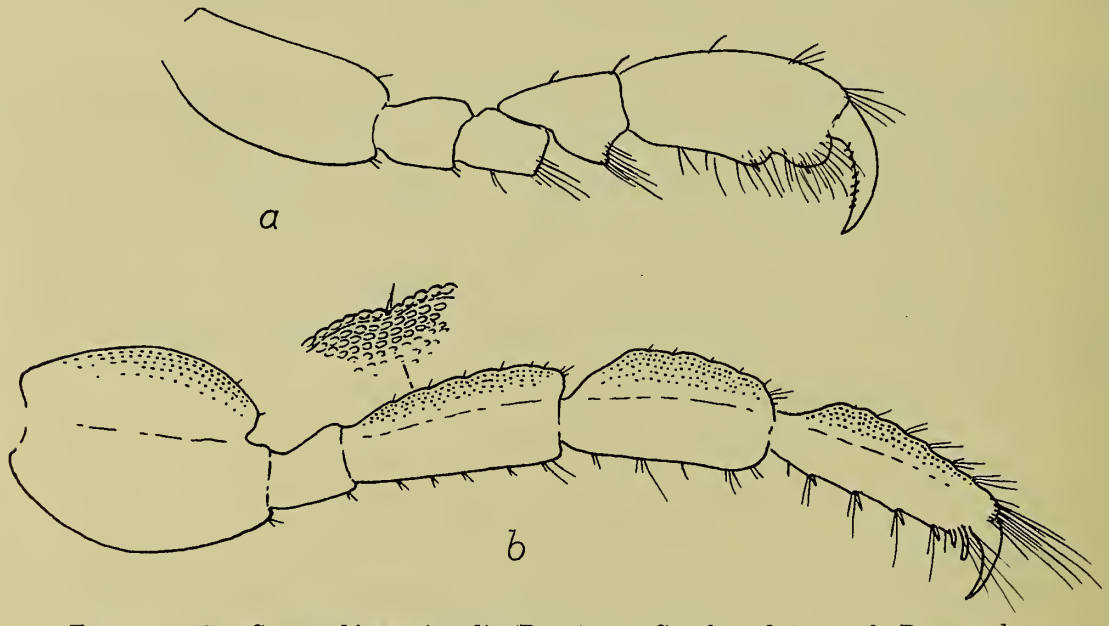
Sunamphitoë orientalis (Dana). (Text-fig. 17.)

Bate, 1862 (Cat. Amph. Brit. Mus.), p. 246, pl. 42, fig. 9 (copy after Dana).
Chevreux, 1900, p. 104.
Stebbing, 1906, p. 641 (*Ampithoë orientalis, species obscura*).

Occurrence :

St. 41. South Arabian coast. 1 ♂ 12 mm.

Remarks.—Chevreux is certainly correct in regarding Dana's species as a *Sunamphitoë*. But whether it is conspecific with *pelagica* is uncertain. I have assigned the present specimen to Dana's species for geographical reasons. Bate's description (from Dana) makes no mention of the 2nd joints of peræopods 4 and 5. The broadly expanded shape



Text-fig. 17.—*Sunamphitoë orientalis* (Dana). *a*, Gnathopod 2, ♂. *b*, Peræopod 5, with surface sculpturing further enlarged.

of this joint in these peræopods, as well as the enlarged and oar-like joints of the 5th peræopod, are features of the present specimen which apparently separate it from the well-known Atlantic *pelagica*.

In gnathopod 1 the 5th joint (measured along anterior margin) is almost as long as the 6th joint. In gnathopod 2 the 5th joint is triangular, as figured for the ♀ *pelagica* by Sars (1894, pl. 208) and by Chevreux & Fage (1925, fig. 348) ; and the 6th is not quite

so robust, appearing as if it required another ecdysis to bring it to the shape figured by these authors. Peræopods 4 and 5, 2nd joint broadly expanded, 4th and 5th joints in peræopod 4 slightly widened, 4th–6th joints in peræopod 5 more strongly expanded; peræopod 4 extending to just beyond end of 5th joint of peræopod 5. Antenna 2 very stout, flagellum subequal to last peduncular joint, 5–6-jointed, 1st joint elongate.

A similar oar-like expansion of peræopod 5 occurs in the South African *Macropisthopous stebbingi* Brnrd.; the latter, however, has a mandibular palp.

Distribution.—Philippine Islands.

Family Corophiidæ.

Gen. *Ericthonius* M. Edw.

Stebbing, 1906, pp. 670, 740.

Ericthonius brasiliensis (Dana).

Chevreux, 1901, p. 437 (*E. abditis* non Templeton).
Walker, 1904, p. 292 (*E. abditus* non Templeton).
,, 1909, p. 343.
Schellenberg, 1928, p. 668.
Shoemaker, 1935, p. 249.

Occurrence:

St. B. Red Sea. 1 ♂ 3·3 mm.
St. Extra. South Arabian coast. 2 ♂♂ 3 mm.
St. 45. South Arabian coast. 2 ♂♂ 2·3–2·5 mm.
St. 53. South Arabian coast. 1 ♂ 3 mm.

Recorded Localities in Indian Ocean.—Ceylon, Zanzibar (Walker); Seychelles (Walker, Chevreux); Suez (Walker, Schellenberg).

Distribution.—Cosmopolitan.

Gen. *Cerapus* Say.

Stebbing, 1906, pp. 665, 740.

Cerapus abditus Templeton.

Giles, 1885, p. 54, pl. 1 (♂) (*calamicola*).
Stebbing, 1888, p. 1163, pl. 125 (♀) (*flindersi*).
,, 1910, p. 616, pl. 55A (references).
Walker & Scott, 1903, p. 229, pl. 14B, fig. 6 (*flindersi*).
Walker, 1904, p. 293 (*calamicola*).
Barnard, 1916, p. 271.

Occurrence:

St. MB II C. South. Arabian coast. A lot, juv., ♀♀ and ♂♂, up to 8 mm., and a large number of tubes.
St. 45. South. Arabian coast. 1 ♂ 7 mm., with tube.
St. 53. South. Arabian coast. 1 ♀ 3·5 mm.

Remarks.—In ♂♂ 5 mm. in length there is a subsidiary denticle on the inner side of the large tooth forming the lower apex of 5th joint of gnathopod 2, and another tooth near the junction hinge of the 6th joint; the latter joint has a denticle in the middle of its

lower margin (*cf.* Stebbing, 1910, fig.). In ♂♂ 6 mm. in length there is a wider gap between the subsidiary denticle and the hinge tooth, and the denticle on the 6th joint has disappeared. In the largest ♂♂, 7·5–8 mm. in length, the hand is very robust, the subsidiary denticle is still present, but the rest of the distal margin forms an unbroken concavity to the junction with the 6th joint, without any hinge-tooth ; the 6th joint is slender, strongly curved, and without denticle.

Colour whitish, mottled with grey.

The tubes are covered with minute fragments of shell, sand-grains and Foraminifera, and measure up to 40 mm. in length.

Recorded Localities in Indian Ocean.—Bay of Bengal (Giles), Ceylon (Walker), Socotra (Walker & Scott).

Distribution.—Australia ; South Africa. Originally (1836) described from Mauritius, as seems probable from Templeton's description ('Trans. Entomol. Soc. London', vol. i, pt. 3, p. 190) of how he observed the animal alive.

Gen. *Siphonœcetes* Kröyer.

Stebbing, 1906, pp. 681, 740, and 1910, p. 618.

Siphonœcetes orientalis Wlkr.

Walker, 1904, p. 294, pl. 7, fig. 49.
Barnard, 1916, p. 270.

Occurrence :

St. MB II C. South Arabian coast. 1 specimen 4 mm.

Remarks.—Both pairs of antennæ missing. Resembling the South African specimens. Telson with shallow apical notch, on either side of which is a narrow transverse band of spinules. Peduncle of uropod 1 with numerous spinules along whole of inner and outer margins ; outer margin of outer ramus and inner margin of inner ramus with numerous spinules, the former also rough with minute scabrosities ; outer margin of inner ramus with close-set serrations. Armature of uropod 2 similar but weaker, with fewer spinules and no scabrosities on outer ramus. The apical lamina at end of peduncle of both uropods is very feebly developed, finely ciliate.

Recorded Locality in Indian Ocean.—Ceylon (Walker).

Distribution.—South Africa.

Family Podoceridæ.

Gen. *Podocerus* Leach.

Stebbing, 1906, pp. 700, 741, and 1910, p. 622.
Barnard, 1916, p. 276, and 1925, p. 366.
Chevreux, 1925 (Bull. Soc. zool. Fr. 50), p. 395.
Chilton, 1926 (Trans. New Zeal. Inst. lii), p. 513.

Remarks.—The following species have been recorded from the Indian region : *andamanensis* (Giles) 1890, *lævis* (Hasw.), *synaptochir* (Wlkr.) 1904, *zeylanicus* (Wlkr.) 1904, *brasiliensis* (Dana). The placing of *synaptochir* as a synonym of *brasiliensis* (Barnard),

1925, p. 366) is accepted by Schellenberg (1928, p. 674). It seems to me that probably *andamanensis* will share the same fate : but *zeylanicus* appears to be valid.

On this basis the following synopsis is given, including the two species added by the John Murray Expedition :

1. Body carinate, with more or less well-developed dorsal processes. Peræopods 1 and 2 with 2nd joint linear . . . . . *palinuri.*
2. Body dorsally rounded, without processes :—
   a. Peræopods 1 and 2, 2nd joint linear, narrow :
      i. Peræopods 3–5, 6th joint strongly spinose . . . . *brasiliensis.*
      ii. Peræopods 3–5, 6th joint feebly spinose . . . . . *lævis.*
   b. Peræopods 1 and 2, 2nd joint expanded on distal front margin :
      i. Peræopods 3–5, 6th joint feebly spinose. Gnathopod 2 ♂ 4th joint not produced, anterior margin with groups of spinules . . . *zeylanicus.*
      ii. Peræopods 3–5, 6th joint almost unarmed. Gnathopod 2 ♂ 4th joint sharply produced, anterior margin without spinules . . . *africanus.*

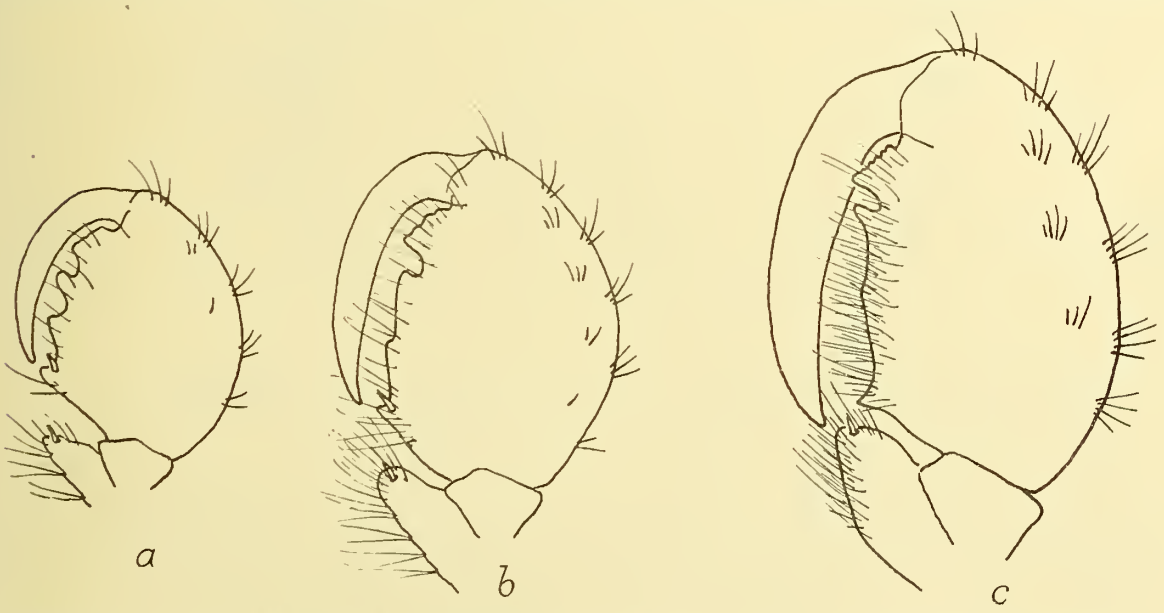
Podocerus palinuri Brnrd. (Text-fig. 18.)

Barnard, 1916, p. 277, pl. 28, fig. 23.

Occurrence :

St. 45. South Arabian coast. 4 specimens 3, 4·5, 5 and 5·5 mm.

Remarks.—These specimens agree with the Cape specimens, except that the 1st side-plate is not so acute, but that is a feature also of young specimens from the Cape.



Text-fig. 18.—*Podocerus palinuri* Brnrd. Growth-changes in hand of gnathopod 2, ♂. *a*, *b*, From specimens 4·5 and 5·5 mm. in length respectively (St. 45). *c*, From type-specimens 7–11 mm. (S. Africa).

Figures are given of the hand of gnathopod 2 ♂ in two of the present specimens, and also of the adult ♂ from the Cape, as the latter has not yet been figured. The hands of gnathopod 2 of the 5-mm. specimen are very setose. The 6th joint of peræopods 1–5 has strong spines on inner margin and groups of weaker spines on outer margin. The two

larger specimens are speckled with grey ; but the smallest one is speckled with pale maroon on the body (including ventral surface) and legs, while the head and hand of gnathopod 2 are uniform white.

There is a very close resemblance between *dancæ* (Stebb.), *cristatus* (G. M. Thoms.), *hystrix* Stebb. and the present species as regards the development of crests and tooth-like processes on the body, and it may be possible to regard one or another of them as synonyms when more abundant material from several sources is available.

In the present species there is a gradual development of the dorsal crests, which are far more prominent in the adult ♂ than in the ♀. In fact a ♀ *palinuri* appears very like a ♂ *cristatus*, because the crests are developed only on the posterior half of the body.

Distribution.—South Africa.

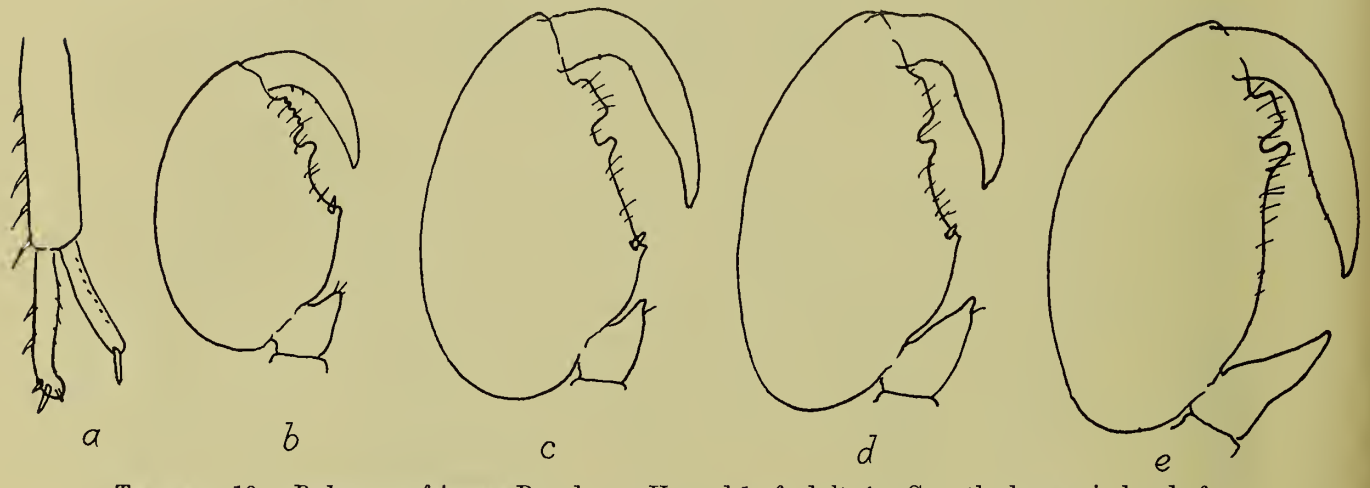
Podocerus africanus Brnrd. (Text-fig. 19.)

Barnard, 1916, p. 278, pl. 28, figs. 24, 25, and 1925, p. 367.

Occurrence :

St. Extra. South Arabian coast. A lot ♂♂, ♀♀ (ovig.) and juv. (adults 5–6 mm.).

Remarks.—Adult and nearly adult ♂♂ with a dense fringe of setæ on lower margins of 4th and 5th peduncular joints of 2nd antennæ (sometimes also on first flagellar joint).



Text-fig. 19.—*Podocerus africanus* Brnrd. *a*, Uropod 1 of adult ♂. Growth-changes in hand of gnathopod 2, ♂. *b*, From specimen 3·5 mm. in length; 2nd antennæ not furry. *c*, *d*, *e*, From specimens 4, 5 and 6 mm. respectively; 2nd antennæ furry.

A feature not noticed in the original description, but present in the South African as well as the present specimens, is the knob-like expansion of the apex of the inner ramus of uropod 1 in the adult (or nearly adult) ♂. Figures are given of the growth-changes in the 2nd gnathopod ♂. The lower margin of the hand is not so setose in the present specimens as in some of the Buffels Bay specimens (Barnard, 1916), and no specimen is as highly developed as the Natal ♂ specimen (Barnard, 1925), in which the upper and lower margins are parallel, the latter being thus concave.

Inner and outer margins of 6th joint of peræopods 1–5 with very few feeble spinules (usually one in middle of outer margin, and 2–3 along inner margin).

Even in juveniles 1·5 mm. in length the 5th joint of gnathopod 1 is as long as the 6th joint, thus forming a clear distinction between the ♂ of this species and that of

mangarevæ Chevr. (1907, p. 521, figs. 33–35). The ♀♀ of the two species, however, are very much alike; both have the rounded lobe-like projection of the 4th joint of gnathopod 2, but (as in the ♂♂) they are distinguished by the basal joints of the peræopods.

Distribution.—South Africa.

Gen. *Lætmatophilus* Bruz.

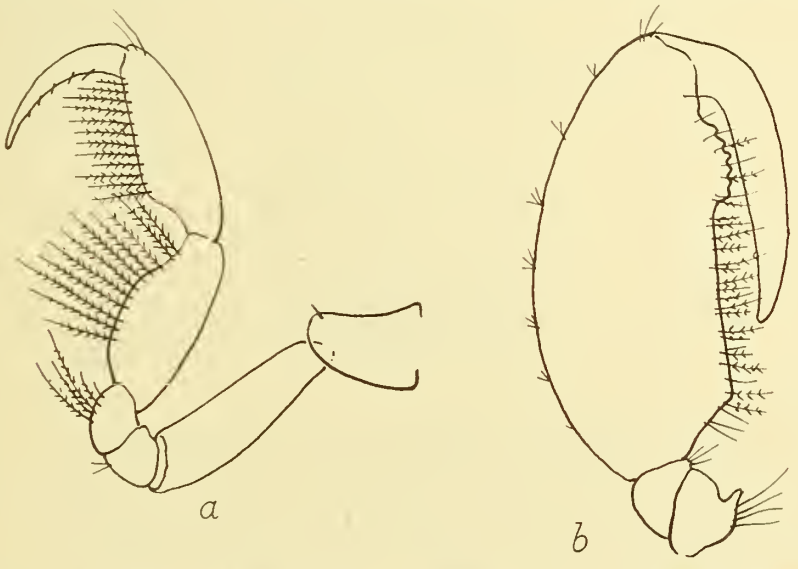
Stebbing, 1906, p. 695.
Barnard, 1916, p. 274.

Lætmatophilus leptocheir n. sp. (Text-fig. 20.)

Occurrence:

St. 45. South Arabian coast. 1 ♂ 4·5 mm.

Description.—Head and 1st peræon segment without dorsal keels. Peræon segment 2 to pleon segment 2 each with a medio-dorsal keel, which on peræon segment 2 is low



Text-fig. 20.—*Lætmatophilus leptocheir* n. sp. *a*, Gnathopod 1, ♂. *b*, Hand of gnathopod 2, ♂.

and rounded, and extends nearly the whole length of the segment, but on the following segments is limited to the posterior half of each segment and becomes tooth-like, acute and directed backwards. On these same segments a dorso-lateral tooth, obscure on peræon segment 2, but becoming more prominent and spiniform posteriorly. Lower margins of peræon segments 2–7 forming keels, projecting over bases of side-plates, those on segments 2, 3 and 4 subhorizontal, the anterior corners produced in short acute points, the hind corners quadrate, those on segments 5–7 projecting horizontally, anterior corners rounded, hind corners acute. Side-plate 1 narrowing below to a rounded apex, side-plates 2–7 subquadrate, with rounded corners, 6 and 7 ending below in a small backwardly directed point. Pleon segment 3 without dorsal armature. Postero-inferior angles of pleon segments 1–3 rounded.

Antenna 1: 1st joint stout, rest slender, 2nd and 3rd subequal or the latter slightly

shorter; 1st flagellar joint $\frac{2}{3}$ length of 3rd joint of peduncle, 2nd joint about $\frac{1}{3}$ the 1st, 3rd and 4th joints minute. Antenna 2 missing.

Gnathopod 1: 6th joint subequal in length to 5th, but slightly narrower, with plumose setæ on inner margin, but without any row of spines near the feeble palmar angle; finger slender.

Gnathopod 2; 2nd joint channelled in front, both edges ending distally in acute lobes; 4th joint with short spiniform projection; 6th elongate, palm long and straight, palmar angle obtuse, a raised crenulate ridge near finger-hinge; whole palm densely clothed with plumose setæ, finger not quite reaching palmar angle.

Uropod 1, peduncle subequal to outer ramus, which is $\frac{2}{3}$ length of inner ramus.

Whitish, speckled with grey.

Remarks.—More strongly cristate than any of the three South African species (Barnard, 1916), but less so than the Australian *hystrix* (Hasw.). The slender hand of gnathopod 1 resembles that of *durbanensis* Brnrd.

HYPERIIDEA.

Family Lanceolidæ.

Gen. *Lanceola* Say.

Barnard, 1932, p. 253.

Lanceola sayana Bov.

Walker, 1909*a*, p. 53.
Pirlot, 1930, p. 2.
Barnard, 1932, p. 254.

Occurrence:

St. 61. (Day.) Northern Arabian Sea. 1 specimen 8 mm.
St. 94. Central Arabian Sea. 1 specimen 14 mm.
St. 96. Central Arabian Sea. 2 specimens 13 and 16 mm.

Recorded Locality in Indian Ocean.—Seychelles (Walker).

Distribution.—Atlantic 56° N. 32½° S.; Indo-Pacific.

Family Mimonectidæ.

Stephensen & Pirlot 1931, p. 503.
Barnard, 1932, p. 252.

The former paper had not reached me when the "Discovery" Report was published. Some of my remarks are no longer tenable.

Gen. *Mimonectes* Bov.

Woltereck, 1904 (June) (Zool. Anz. xxvii), pp. 621, 629 (*Sphæromimonectes*).
Stebbing, 1904 (November) (Tr. Linn. Soc. London, x), p. 20 (*Parascina*).
Barnard, 1930, p. 395 (*Parascina*).
Stephensen & Pirlot, 1931, pp. 503, 552.

Mimonectes chevreuxi (Pirlot).

Stephensen, 1918, p. 17, figs. 5, 6 (*Parascina fowleri*, non Stebbing).
Pirlot, 1929, p. 56 (*Parascina chevreusi* [*sic*]), and 1930, p. 7.
Stephensen & Pirlot, 1931, p. 528, figs. I 4, II 5, and XI.
Barnard, 1932, p. 253.

Occurrence :

St. 172. Central Arabian Sea. 1 juv. 6 mm.

Remarks.—Stephensen & Pirlot (1931, pp. 506, 530) are almost certain that this form represents the ♂ of *M. loveni* Bov. (*l. c.* 1931, p. 507, figs. I 1, 2, II 1–3, III, IV). With the exception of one specimen captured by the Siboga Expedition in the East Indies, it has not been captured outside the Atlantic region.

In the present specimen the 4th and 5th joints of peræopod 3 (5) and the 5th joint of peræopod 5 (7) are more prominently expanded and oar-like than in Stephensen's figure. The 2nd antennæ are minute, consisting of a short basal joint and a narrower 2nd joint.

Distribution.—*chevreuxi :* Atlantic (Iceland to Madeira and Azores), East Indies (3° 20′ S. 127° 22′ E.).

loveni : Atlantic (Greenland to Gulf of Guinea, Barbados).

Family Scinidæ.

Stephensen & Pirlot, 1931, p. 551.

Gen. *Proscina* Steph. Pirlot.

Stephensen & Pirlot, 1931, p. 543.
Pirlot, 1932 (Ann. Inst. oceanogr. n.s. xii, fasc. 1), p. 23.

Proscina stephenseni (Pirlot). (Text-fig. 21).

Pirlot, 1929, p. 58, fig. 4 (♀) (*Parascina s.*).
Stephensen & Pirlot, 1931, p. 544, fig. xvii (mxp. & prp. 2, ♀).
? *Id., ibid.*, p. 545, fig. xvii (*magna* ♂).

Occurrence :

St. 131 (day, 1500 m.). Southern Arabian Sea. 1 ♂ about 6 mm.

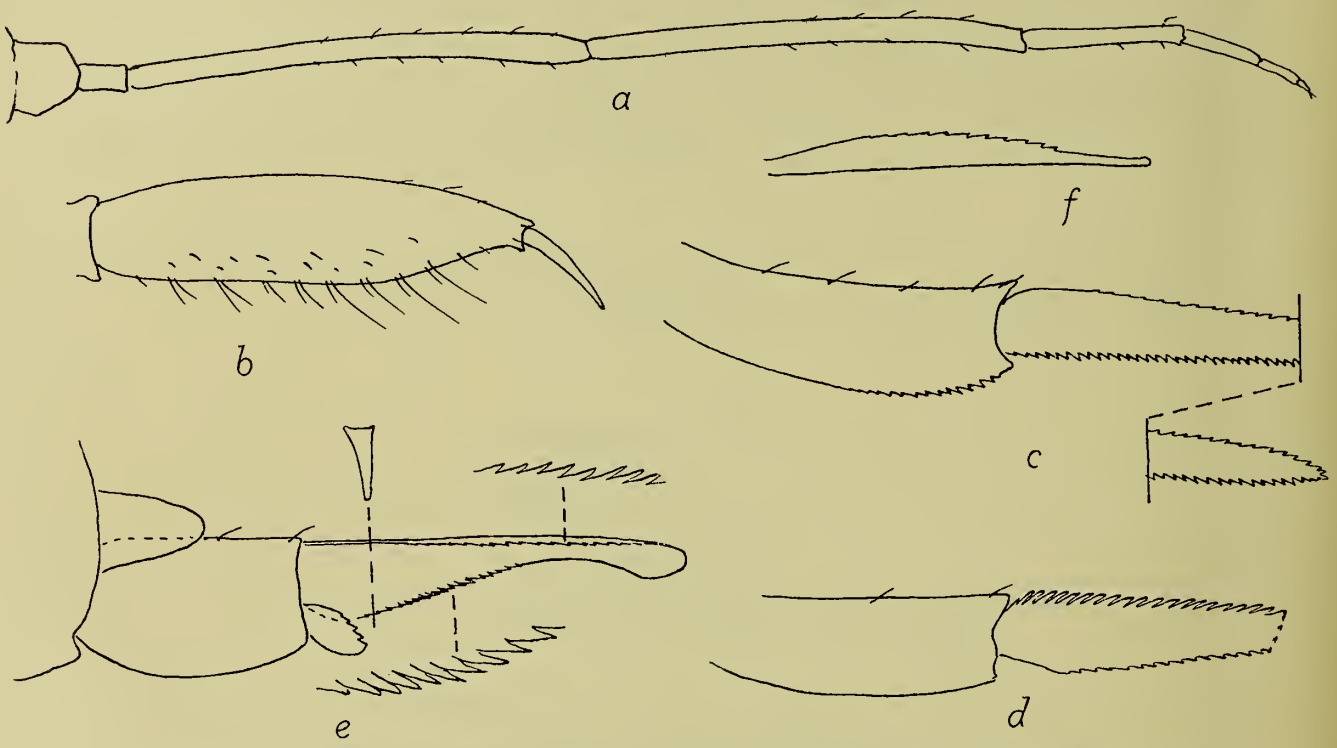
Description.—First antennæ as long as, or a little longer than peræon (3 mm.); flagellar joint very stout, triquetral, without any minute apical joints; the apex subacute and apparently uninjured, a thick brush of long setæ on the inner surface ; owing to the closely aggregated bases of these setæ the inner margin appears by transmitted light as a dark opaque stripe, while the outer part of the joint is transparent ; outer margin entire and glabrous. Second antennæ as long as the first antennæ, very slender, consisting apparently of a bulbous basal joint, followed by a short joint, then an elongate joint extending about $\frac{1}{3}$ along the flagellar joint of 1st antenna, then another elongate joint extending about $\frac{2}{3}$ along 1st antenna, and a flagellum of 3 or 4 joints, of which the 1st is the longest.

Gnathopod 1 as figured by Pirlot, with brush of setæ on anterior distal margin of 6th joint. Gnathopod 2 not more slender than gnathopod 1, as figured by Stephensen

& Pirlot. Peræopods 1–5 slender, as figured by Pirlot; peræopod 4 not longer than peræopod 3 and scarcely more slender than peræopod 5.

Pleopods large and robust; outer margins of peduncles more convex than in Stephensen's figure of *P. fowleri* (1918, fig. 5).

Uropod 1, peduncle serrate on outer distal margin; ramus (only one present) longer than peduncle, strongly serrate on both margins as far as the subacute apex. Uropod 2, peduncle apparently smooth on both margins; ramus (only one present, incomplete) similar to that of uropod 1. Uropod 3, peduncle stout, both margins smooth; outer ramus very small, ovate, serrate on its inner distal margin; inner ramus elongate, triquetral in



Text-fig. 21.—*Proscina stephenseni* (Pirlot). *a*, Antenna 2. *b*, Apical joints of gnathopod 2. *c*, Uropod 1. *d*, Uropod 2. *e*, Telson and uropod 3, with cross-section of inner ramus of latter. *f*, Inner view of inner ramus of uropod 3.

cross-section, the inner side straight and capable of fitting closely against its fellow, the inner lower margin smooth, inner upper margin serrate, outer margin sinuous; narrowing as far as the distal third, then swelling out in a slightly spatulate shape, serrate except in the distal third. Telson about $\frac{1}{2}$ length of peduncle of uropod 3, longer than broad, apex rounded.

Remarks.—This very interesting specimen is delicate, but in fair condition, barring the mutilation of the uropods and mouth-parts. It is the *third specimen* of this genus to be captured. There is little doubt that it is a ♂, in view of the length of the 2nd antennæ. The shape of the 3rd uropods may also prove to be a sexual character.

The specimen agrees with *stephenseni*, but has the 2nd gnathopod and 3rd uropod of *magna*. As, moreover, *stephenseni* was described from a ♀, and *magna* from a ♂, the presumption is not unreasonable that eventually *magna* will prove to be synonymous.

Distribution.—47° N. 18° W. (*stephenseni*); 36° N. 28° 53′ W. (*magna*).

Gen. *Scina* Prest.

Wagler, 1926 (revision and key to species).

Scina crassicornis (Fabr.).

Walker, 1909*a*, p. 52 (*cornigera*).
Stephensen, 1918, p. 19.
Wagler, 1926, p. 324, figs. 2, 3.
Barnard, 1932, p. 258.

Occurrence :

St. 96. Central Arabian Sea. 1 ♀ 11 mm.

St. 131 (night). Southern Arabian Sea. 1 specimen 7·5 mm.

Recorded Localities in Indian Ocean.—2° N.–32° S. (Bovallius, Stephensen) ; Seychelles (Walker) ; Indian Ocean between 29° S. and $2\frac{1}{2}$° N., $89\frac{1}{2}$°–$76\frac{1}{2}$° E. (Wagler).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Scina curvidactyla Chevr.

Barnard, 1932, p. 259.

Occurrence :

St. 131. Southern Arabian Sea. 1 specimen 8 mm.

St. 172. Central Arabian Sea. 2 juv. 3·5 mm.

St. 186. Gulf of Aden. 1 ♀ 10 mm.

Recorded Localities in Indian Ocean.—Bay of Bengal, Chagos, and Seychelles (Wagler).

Distribution.—Atlantic, Mediterranean, Pacific.

Scina borealis (G. O. Sars).

Wagler, 1926, p. 337, figs. 9–11.
Barnard, 1930, p. 401, and 1932, p. 260.

Occurrence :

St. 186. Gulf of Aden. 23 specimens 4–5 mm.

Recorded Localities in Indian Ocean.—Bay of Bengal, Chagos and Seychelles, East African coast, Gulf of Aden (Wagler).

Distribution.—Atlantic, Mediterranean, Arctic and Antarctic, Southern Indian Ocean, Pacific.

Scina marginata Bov.

Wagler, 1926, p. 361, figs. 19–21.
Barnard, 1932, p. 261.

Occurrence :

St. 61 (night, 1136 metres wire out). Northern Arabian Sea. 1 ♂ 4·5 mm., 2 ♀♀ 4 and 5 mm.

Remarks.—The closely allied species *submarginata* Tattersall has been recorded from the Seychelles, Amirante and Cape Guardafui (Wagler).

Distribution.—Atlantic, Mediterranean.

Family Vibiliidæ.

Gen. *Vibilia* M. Edw.

Barnard, 1932, p. 262.

Vibilia propinqua Stebb.

Stephensen, 1918, p. 43, fig. 14.
Barnard, 1932, p. 263.

Occurrence :

St. 95. Central Arabian Sea. 5 ♀♀ 7·5–8 mm.

Recorded Localities in Indian Ocean.—7° N.–35° S. (Behning).

Distribution.—Atlantic, Mediterranean, Eastern Pacific.

Vibilia armata Bov.

Walker, 1909*a*, p. 53 (*gracilenta*).
Stephensen, 1918, p. 46, figs. 15, 16.
Pirlot, 1930, p. 11.
Barnard, 1931, p. 126, and 1932, p. 264.

Occurrence :

St. 61 (day, 1702 metres wire out). Northern Arabian Sea. 8 ♂♂, 13 ♀♀, 5–7·5 mm.

St. 61 (night, 1702 metres wire out). 13 ♂♂, 14 ♀♀, 5–7 mm.

St. 76 (800 metres wire out). Gulf of Oman. 2 ♂♂, 3 ♀♀, 6 mm.

St. 76 (1800 metres wire out). 1 ♂ 6 mm.

St. 96. Central Arabian Sea. 1 ♂ 6 mm., 2 ♀♀ (1 with embryos) 7 mm.

St. 145d (300–0 metres). Maldives. 1 ♀, with embryos, 5·5 mm.

Recorded Localities in Indian Ocean.—Seychelles (Walker), Indian Ocean (Behning).

Distribution.—Atlantic, Mediterranean, Australasia, East Indies, Eastern Pacific.

Vibilia pyripes Bov.

Stephensen, 1918, p. 52, fig. 17.
Barnard, 1932, p. 265.

Occurrence :

St. 61 (day, 566 metres wire out). Northern Arabian Sea. 4 ♂♂ 9–11 mm., 3 ♀♀ (1 with embryos).

St. 61 (day, 1136 metres wire out). 3 ♂♂ 9 mm.

St. 61 (day, 1702 metres wire out). 2 ♂♂ 10 mm.

St. 61 (night, 1136 metres wire out). 16 ♂♂ 9–11·5 mm.

St. 61 (night, 2265 metres wire out). 1 ♂ 11 mm.

St. 76. Gulf of Oman. 3 ♂♂ 9·5–10·5 mm.

Recorded Localities in Indian Ocean.—Near Equator (Behning).

Distribution.—Atlantic, Eastern Pacific.

Vibilia sp.

Occurrence :

St. 145c (50–0 metres). Maldives. 4 juv. 2 mm. in atrial cavity of a large Salp.

Family Paraphronimidæ.

Gen. *Paraphronima* Claus.

Spandl, 1927, p. 165 (key to species).

Paraphronima gracilis Claus.

Walker, 1909*a*, p. 52.
Spandl, 1927, p. 165, fig. 6.
Pirlot, 1930, p. 12.
Barnard, 1932, p. 267.

Occurrence :

St. 61 (night, 1136 metres wire out). Northern Arabian Sea. 3 ♂♂ 4·5–5 mm., 7 ♀♀ 5–6 mm.

Recorded Localities in Indian Ocean.—Chagos, Seychelles, Mauritius (Walker).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Paraphronima crassipes Claus.

Bovallius, 1889, p. 33, pl. 2, figs. 16–40 (*clypeata*).
Spandl, 1927, p. 166.
Barnard, 1932, p. 267.

Occurrence :

St. 131. Southern Arabian Sea. 1 ♀ 13 mm. (length of head = depth of head, 3·5 mm.).

St. 172. Central Arabian Sea. 1 ♂ (penultimate instar) 9 mm.

St. 186. Gulf of Aden. 1 ♀ 11·5 mm.

Remarks.—This is the first record of this species in the Indian Ocean. Both these specimens agree with Bovallius' figures of the form *clypeata* in having stout 2nd joints to the peræopods, and stout uropods ; the rami of uropod 3 are not longer than the breadth of the peduncle.

Distribution.—Mediterranean, Atlantic, Pacific.

Family Hyperiidæ.

Bovallius, 1889, p. 74 (key to genera).
Spandl, 1927, p. 151 (key to genera).

Gen. *Hyperia* Latr.

Bovallius, 1889, p. 129 (key to species).
Spandl, 1927, p. 153.
Barnard, 1932, p. 273.

Hyperia promontorii Stebb.

Stebbing, 1888, p. 1385, pl. 166 B (♂), and p. 1391, pl. 168 (♀ *schizogeneios*).
Barnard, 1930, p. 411.
Pirlot, 1930, p. 16 (*schizogeneios*).

Occurrence :

St. 61 (night, surface). Northern Arabian Sea. 3 ♂♂ penult. instar 3 mm., 97 ♂♂ 3–3·5 mm., 20 ♀♀ (some ovig.) 2·5–3 mm.

Remarks.—As in the "Terra Nova" collection all the ♂♂ are *promontorii* (first 2 peræon segments fused), and all the ♀♀ are *schizogeneios* (first 3 peræon segments fused).

Distribution.—Atlantic 40° N.–45° S.; Mediterranean; East Indies; New Zealand.

Hyperia crucipes Bov.

Bovallius, 1889, p. 225, pl. 11, figs. 14–25.
Walker, 1904, p. 236.
Stephensen, 1924, p. 90.

Occurrence:

St. 76. Gulf of Oman. 4 juv. 1·3–2 mm.

St. 101. Central Arabian Sea. 1 ovig. ♀ 4 mm.

St. 172 (510 metres wire out). Central Arabian Sea. 1 ♀ 3 mm.

Remarks.—The identification of the juveniles should be taken with caution.

Recorded Locality in Indian Ocean.—Ceylon (Walker).

Distribution.—Tropical Atlantic.

Hyperia sp.

Occurrence:

St. 136. Maldives. 2 juv. 1–1·3 mm.

Gen. *Hyperioides* Chevr.

Chevreux, 1900, p. 143.
Vosseler, 1901, p. 56 (*Parahyperia*).
Stebbing, 1904, p. 34.

Hyperioides longipes Chevr.

Barnard, 1930, p. 414 (references), and 1932, p. 276 (references).

Occurrence:

St. 186. Gulf of Aden. 1 ♂ 5·3 mm.

Distribution.—Atlantic, Mediterranean, Northern New Zealand seas to 52° S.

Family Dairellidæ.

Barnard, 1932, p. 282.

Gen. *Dairella* Bov.

Barnard, 1932, p. 282.

Dairella latissima Bov.

Bovallius, 1889, p. 336, pl. 15, figs. 1–20.
Barnard, 1932, p. 282.

Occurrence:

St. 186. Gulf of Aden. 1 ♀ 4 mm.

Remarks.—The first record of this species in the Indian Ocean.

Distribution.—Atlantic, Mediterranean.

Family Phronimidæ.

Gen. *Phronima* Latr.

Barnard, 1932, p. 282.

Phronima sedentaria (Forsk.).

Walker, 1909*a*, p. 51.
Pirlot, 1930, p. 12.
Barnard, 1932, p. 283.

Occurrence :

St. 5. Red Sea. 1 ♀ 14 mm.
St. 7. Northern Arabian Sea. 1 ♀ 12 mm.
St. 61 (day, 2265 metres wire out). Northern Arabian Sea. 1 ♀ 15 mm.
St. 61 (night, 2265 metres wire out). 3 ♀♀ 12–15 mm.
St. 95. Central Arabian Sea. 1 ♂ 8·5 mm., 29 ♀♀ 15–24 mm., with houses.
St. 96. Central Arabian Sea. 3 ♂♂ 7·5–10·5 mm., 9 ♀♀ 11–22 mm., with houses.
St. 98. Central Arabian Sea. 2 ♀♀ 18 and 26 mm.
St. 108. Zanzibar area. 1 ♀ 26 mm.
St. 121. Zanzibar area. 2 ♀♀ 28 and 30 mm.
St. 131. Southern Arabian Sea. 2 ♀♀ 18 and 21 mm.
St. 172 (510 metres wire out). Central Arabian Sea. 1 ♀ 18 mm. in house, 4 ♀♀ 7, 10, 11, 13 mm., 2 juv. 2·5–3 mm.
St. 172 (2665 metres wire out). 1 ♀ 18 mm., 1 ♀ in house 16 mm.
St. 184. Gulf of Aden. 1 ♀ 17 mm.
St. 186 (880 metres wire out). Gulf of Aden. 1 ♀ 16 mm.
St. 186 (1500 metres wire out). 1 ♀ 17 mm.

Remarks.—In one of the houses from St. 95 there are two groups of juveniles, comprising 7 and 9 individuals, in the 3rd and 4th instars (6 of the 3rd and 1 of the 4th, and 7 of the 3rd and 2 of the 4th respectively). This seems to bear out the statements of Minkiewicz and Stephensen, but there is the possibility that some of the juveniles have been pressed out of the house in the process of capture and preservation.

Recorded Localities in Indian Ocean.—Chagos, Seychelles (Walker).

Distribution.—Mediterranean, Atlantic, Indo-Pacific (Borneo, Bate, 1862).

Phronima atlantica Guér.

Spandl, 1924, p. 24.
Stephensen, 1924, p. 121.
Pirlot, 1930, p. 14.
Barnard, 1932, p. 285.

Occurrence :

St. 61. Northern Arabian Sea. 1 ♀ 7 mm.

Recorded Localities in Indian Ocean.—28°–29° S. 96°–97½° E. (Stephensen); Red Sea (Spandl).

Distribution.—Mediterranean, Atlantic, Indo-Pacific, Antarctic.

Phronima atlantica var. *solitaria* Guér.

Stephensen, 1924, p. 125.

Occurrence :

St. 7. Red Sea. 14 ♀♀ 12–16 mm. with houses, 2 ovig. ♀♀ 13 and 14 mm.

St. 61. Northern Arabian Sea. 1 ♀ 10 mm.

Recorded Localities in Indian Ocean.—Without special locality (Bovallius).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Phronima colletti Bov.

Bovallius, 1887 (Bih. K. Sv. Vet. Ak. Handl. xi), p. 25 (published not later than October*).
Giles, 1887 (*bucephala*) (published November 2nd*).
Stephensen, 1924, p. 127.
Pirlot, 1930, p. 14.
Barnard, 1932, p. 286.

Occurrence :

St. 61 (night, surface). Northern Arabian Sea. 97 ♂♂ ult. instar 6–6·5 mm.

St. 61 (night, 1136 metres wire out). 21 ♂♂ penult. and ult. instars 6–7 mm., 64 ♀♀ 6–8 mm.

St. 61 (night, 1702 metres wire out). 2 ♂♂ 5–6 mm., 10 ♀♀ 5–7 mm.

St. 186 (1150 metres wire out). Gulf of Aden. 1 ♀ 5·5 mm.

Recorded Localities in Indian Ocean.—Bay of Bengal (Giles), 22° 44′ S. 86° E. (Stephensen).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Gen. *Phronimella* Claus.

Stephensen, 1924, p. 130.

Phronimella elongata (Claus).

Giles, 1887 (*Phronima hippocephala*).
Walker, 1909*a*, p. 51.
Stephensen, 1924, p. 130.
Pirlot, 1930, p. 15.
Barnard, 1932, p. 286.

Occurrence :

St. 61 (day, 1702 metres wire out). Northern Arabian Sea. 1 ♂ penult. instar 5 mm., 4 ♀♀ 8–9 mm.

St. 61 (night, surface). 23 ♂♂ ult. instar 6–7·5 mm.

St. 61 (night, 1136 metres wire out). 8 ♂♂ penult. and ult. instars 5–7 mm., 10 ♀♀ 5–11 mm.

St. 61 (night, 1702 metres wire out). 2 ♂♂ 6–6·5 mm., 5 ♀♀ 6–7 mm.

St. 131D. Southern Arabian Sea. 3 ♂♂ 5–6 mm., 1 ♀ 6 mm.

* Bovallius' paper was received at the British Museum (Nat. Hist.) library in October, whereas Giles' paper was published on November 2nd, according to information kindly supplied by Dr. C. D. Sherborn and Dr. Chopra respectively.

Recorded Localities in Indian Ocean.—Bay of Bengal (Giles); Ceylon to Mauritius to Seychelles (Walker); 27°–40° S. 53°–101° E. (Stephensen).

Distribution.—Mediterranean, Atlantic, Indo-Pacific, Antarctic.

Family Phrosinidæ.

Gen. *Phrosina* Risso.

Bovallius, 1889, p. 421.

Phrosina semilunata Risso.

Walker, 1904, p. 230, and 1909*a*, p. 52.
Spandl, 1924, p. 26.
Stephensen, 1924, p. 138.
Pirlot, 1930, p. 23.

Occurrence:

St. 61 (night, 1136 metres wire out). Northern Arabian Sea. 18 ♀♀ (some ovig.) 6·5–8 mm.

St. 61 (night, 1702 metres wire out). 14 ♀♀ (some ovig.) 6–8 mm.

St. 61 (night, 2265 metres wire out). 1 ♀ 8 mm.

St. 131 (day, 1500 metres). Southern Arabian Sea. 1 ovig. ♀ 13 mm.

St. 131 (night, 600 metres). 3 ♀♀ 11, 15, 16 mm., 2 ovig. ♀♀ 17 and 21 mm.

St. 172 (1500 metres wire out). Central Arabian Sea. 1 ovig. ♀ 15 mm.

St. 172 (2665 metres wire out). 1 ♀ 11 mm.

Recorded Localities in Indian Ocean.—Socotra to Ceylon (Walker); Chagos, Mauritius, Seychelles (Walker); 26°–40° S. 24°–72° E. (Stephensen); Red Sea (Spandl).

Distribution.—Mediterranean, Atlantic, Indo-Pacific, Antarctic.

Gen. *Primno* Guér.

Stebbing, 1904 (Trans. Linn. Soc. Lond. x), p. 38.

Primno macropa Guér.

Walker, 1909*a*, p. 52.
Spandl, 1924, p. 25.
Stephensen, 1924, p. 143.
Pirlot, 1930, p. 22 (*Euprimno macropus*).
Barnard, 1932, p. 287, pl. 1, fig. 8 (coloured).

Occurrence:

St. 131 (600 metres). Southern Arabian Sea. 2 mutilated specimens.

St. 131 (1500–0 metres). 1 ovig. ♀ 5 mm.

St. 172. Central Arabian Sea. 1 ♂ 6 mm., 5 ♀♀ 4·5–6·5 mm.

Recorded Localities in Indian Ocean.—Mauritius, Seychelles, Chagos (Walker); Red Sea (Spandl); 4°–38° S. 30°–71° E. (Stephensen).

Distribution.—Mediterranean, Atlantic, Indo-Pacific, Antarctic.

Gen. *Anchylomera* M. Edw.

Bovallius, 1889, p. 408.

Anchylomera blossevillei M. Edw.

Walker, 1904, p. 230, and 1909*a*, p. 52.
Spandl, 1924, p. 26.
Stephensen, 1924, p. 134.
Pirlot, 1930, p. 21.

Occurrence :

St. 61 (night, surface). Northern Arabian Sea. 3 ♂♂ penult. instar 4·5–5·5 mm., 16 ♂♂ ult. instar 6–6·5 mm., 83 ♀♀ (some ovig.) 4–6 mm., 21 juv. 2·5–4 mm.

St. 61 (night, 1136 metres wire out). 1 ♂ 7 mm., 2 ovig. ♀♀ 5–5·5 mm., 4 ♀♀ 3–4 mm.

St. 61 (night, 1702 metres wire out). 4 ♀♀ 4·5–5·5 mm.

Recorded Localities in Indian Ocean.—Socotra to Ceylon (Walker); Chagos, Cargados (Walker); 11°–38° S., 30°–103° E. (Stephensen); Red Sea (Spandl).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Family Pronoidæ.

Gen. *Pronoë* Guér.

Stebbing, 1888, p. 1507.

Pronoë capito Guér.

Walker, 1909*a*, p. 54.
Spandl, 1924, p. 34, fig., and 1927, p. 217.

Occurrence :

St. 172. Central Arabian Sea. 1 ♂ 10·5 mm., 1 ♀ 10 mm.

Recorded Localities in Indian Ocean.—Zanzibar, Indian Ocean, Moluccas (Claus); Red Sea (Spandl); Chagos, Seychelles (Walker).

Distribution.—Mediterranean, N. Atlantic, Indian Ocean, S. Pacific.

Gen. *Eupronoë* Claus.

Spandl, 1927, p. 222.

Eupronoë maculata Claus.

Stephensen, 1925, p. 156, figs. 53, 54.
Pirlot, 1930, p. 33.
Barnard, 1932, p. 289.

Occurrence :

St. 61. Northern Arabian Sea. 1 ovig. ♀ 6 mm.

St. 186 (510 metres wire out). Gulf of Aden. 2 ♀♀, with embryos, 7 and 7·5 mm.

St. 186 (1150 metres wire out). 2 ♀♀, with embryos, 7·5 mm.

Recorded Localities in Indian Ocean.—Zanzibar (Claus); 8° N. 83° 52′ E. (Ceylon) (Stephensen).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Eupronoë armata Claus.

Spandl, 1927, p. 224, fig. 42, and p. 222 (*intermedia*).
Barnard, 1930, p. 427.

Occurrence :

St. 145. Maldives. 2 ♀♀ 3·5–4 mm.

Recorded Locality in Indian Ocean.—Zanzibar (Claus).

Distribution.—Atlantic, Madagascar, East Indies.

Gen. *Parapronoë* Claus.

Barnard, 1932, p. 290.

Parapronoë crustulum Claus.

Walker, 1909*a*, p. 54.
Spandl, 1927, p. 220, fig. 39 (*stebbingi*), and p. 221, fig. 40.
Pirlot, 1930, p. 31.

Occurrence :

St. 120. Zanzibar area. 1 ovig. ♀ 23 mm.

St. 172 (510 metres wire out). Central Arabian Sea. 2 ♀♀ 12 and 14 mm.

St. 172 (820 metres wire out). 1 ♀ 11 mm.

St. 172 (2665 metres wire out). 1 ♀ 19 mm.

Remarks.—Lower margin of 5th joint of gnathopod 1 serrate or strongly serrate, the joint itself of the shape of that of *clausoides* Stebb. (1888, pl. 191). Anterior margin of 2nd joint of peræopod 4 smooth. Peræopod 5 with 2 minute terminal joints. Telson with margins evenly convex. Brick-red (rather faded in some specimens), the chromatophores deeper red, eyes dull maroon.

Recorded Localities in Indian Ocean.—Zanzibar (Claus) ; Seychelles (Walker).

Distribution.—Atlantic, Indo-Pacific.

Parapronoë clausoides Stebb.

Walker, 1909*a*, p. 54.
Barnard, 1932, p. 290, fig. 165.

Occurrence :

St. 172 (510 metres wire out). Central Arabian Sea. 3 ♀♀ 17–19 mm.

Remarks.—Lower margin of 5th joint of gnathopod 1 feebly serrulate. Anterior margin of 2nd joint of peræopod 4 strongly serrate distally.

Recorded Locality in Indian Ocean.—Seychelles (Walker).

Distribution.—Australia, Indian Ocean, Atlantic.

Gen. *Sympronoë* Stebb.

Stebbing, 1888, p. 1533.

Sympronoë parva (Claus).

Walker, 1904, p. 230, and 1909*a*, p. 54.
Spandl, 1927, p. 225, fig. 43.
Pirlot, 1930, p. 32.
Barnard, 1932, p. 291.

Occurrence :

St. 61 (1133 metres wire out). Northern Arabian Sea. 1 ♂ 6 mm.

St. 61 (1702 metres wire out). 2 ♀♀ 6 mm.

St. 186. Gulf of Aden. 1 ♂ 6 mm.

Recorded Localities in Indian Ocean.—Zanzibar (Claus); Socotra to Ceylon (Walker); Seychelles (Walker).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Family Lycæidæ.

Gen. *Lycœa* Dana.

Barnard, 1930, p. 428 (provisional key to species).

Lycœa pulex Marion.

Giles, 1887, p. 220, pl. 5 (*Amphipronoë longicornuta*).
Walker, 1909*a*, p. 54 (*similis*).
Chevreux and Fage, 1925, p. 429, fig. 419 (♀).
Stephensen, 1925, p. 167.
Pirlot, 1930, p. 24.

Occurrence :

St. 61 (night, surface). Northern Arabian Sea. 12 ♂♂ penult. and ult. instars 3·5–4·5 mm., 15 ♀♀, some ovig. 3·75–4 mm.

Remarks.—Pirlot considers that not only *similis*, *longicornuta* and *bajensis*, but also *gracilis* (with a query), are synonymous with Marion's species. As regards *gracilis*, Spandl (1924) describes and figures the 6th joint of gnathopod 2 as tapering distally. Chevreux & Fage describe and figure the 6th joint of gnathopod 1 as having a strong tooth in distal third of the lower margin in ♀. In the present specimens the ♀♀ do not differ from the ♂♂ in this respect, the 6th joint in both gnathopods 1 and 2 having the normal shape, with feebly concave lower margin and quadrangular, more or less projecting, lower distal corner. I think there is no doubt that Giles' specimens and the present ones are the same species. A revision of the genus is desirable.

Recorded Localities in Indian Ocean.—Chagos (Walker, *similis*); Red Sea (Spandl); Bay of Bengal (Giles, *longicornuta*).

Distribution.—Subtropical and tropical Atlantic, Mediterranean, East Indies. (*L. bajensis* is recorded from California, New Zealand, and the Great Barrier Reef.)

Family Brachyscelidæ.

Gen. *Brachyscelus* Bate.

Stephensen, 1925, p. 172.

Brachyscelus globiceps Claus.

Stebbing, 1888, p. 1550, pl. 197, fig. B (*latipes*).
Stephensen, 1925, p. 176, fig. 65.
Barnard, 1932, p. 293 (reference to Stebbing wrongly quoted, also in Stephensen).

Occurrence :

St. 61 (night, surface). Northern Arabian Sea. 1 ♀ 6 mm., 1 ovig. ♀ 7 mm.

St. 61 (day, 1136 metres wire out). 2 ovig. ♀♀ 7 mm.

St. 172 (510 metres wire out). Central Arabian Sea. 1 ♂ 11 mm. (breadth of head 3 mm., of peræon 4 mm.). 1 ♀ with embryos 7 mm., 1 ♀ 5 mm.

St. 172 (820 metres wire out). 4 ♀♀ (1 ovig.) 6·5–7·5 mm.

St. 186 (1150 metres wire out). Gulf of Aden. 2 ♀♀ 6 mm.

Remarks.—Telson and uropods in ♂ agreeing with Stebbing's figure, though the telson is not quite so broadly rounded, in ♀ telson more like Stephensen's figure, but outer ramus of uropod 3 at least $\frac{4}{5}$ length of inner ramus. Second joint of peræopod 3 very broad in ♂, not so broad in ♀. Anterior margins of 2nd joints of peræopods 3 and 4 almost smooth. No conspicuous scale-markings on integument.

It is not definitely certain that these specimens belong to Claus' species (*cf.* also Stephensen and Barnard, *l. c.*), or even that the ♂ and ♀ are conspecific. An examination of a much larger amount of material is necessary before the limits of the species in this genus can be satisfactorily determined. (Boone, ' Bull. Vanderbilt Mus.' vi, p. 226, 1935, describes and figures *B. stebbingi* n. sp.)

Recorded Locality in Indian Ocean.—Zanzibar (Claus).

Distribution.—Mediterranean, S. Pacific.

Gen. *Thamneus* Bov.

Stebbing, 1888, p. 1558.
Barnard, 1932, p. 293.

Thamneus platyrhynchus Stebb.

Stebbing, 1888, p. 1558, pl. 198.
Walker, 1909*a*, p. 54.
Stephensen, 1925, p. 180, figs. 69, 70 (*Euthamneus p.*).
Barnard, 1932, p. 293.

Occurrence :

St. 61 (day, surface). Northern Arabian Sea. 1 ♂ 5 mm.

St. 101. Central Arabian Sea. 4 ♀♀ 3–6 mm.

Remarks.—Colour as preserved, pinkish, the whole dorsal surface with darker red stellate specks, eyes maroon.

Recorded Localities in Indian Ocean.—4° 48′ S. 67° 22′ E., and 9°–12° S. 60°–62° E. (Walker); 8° N. 83° 51′ E. (Stephensen).

Distribution.—Atlantic, Mediterranean, Cape of Good Hope, Pacific.

Family Oxycephalidæ.

Gen. *Simorhynchotus* Stebb.

Simorhynchotus antennarius (Claus).

Stebbing, 1888, p. 1572, pl. 200.
Stephensen, 1925, p. 185, fig. 72.
Barnard, 1930, p. 433, and 1931, p. 130.

Occurrence :

St. 61 (night, surface). Northen Arabian Sea. 8 ♂♂ 5–5·5 mm.

Recorded Localities in Indian Ocean.—Zanzibar (Claus), Bay of Bengal (Stephensen).

Distribution.—Atlantic, Mediterranean, Pacific.

Gen. *Oxycephalus* M. Edw.

Spandl, 1927, p. 179.
Cecchini, 1929, p. 5.

Oxycephalus clausi Bov.

Walker, 1909*a*, p. 55.
Stephensen, 1925, p. 188.
Cecchini, 1929, p. 5, pl. 1.
Barnard, 1932, p. 294.

Occurrence :

St. 96 (15 metres wire out). Central Arabian Sea. 10 juv. 6–9 mm.
St. 96 (914 metres wire out). 2 ♀♀ 15 and 22 mm.
St. 122. Zanzibar area. 1 ♀ 30 mm.
St. 131 (day, 2500 metres). Southern Arabian Sea. 1 ♀ 25 mm.
St. 172 (1500 metres wire out). Central Arabian Sea. 1 ♂ 19 mm.
St. 172 (2665 metres wire out). 1 ♂ 15 mm.

Recorded Localities in Indian Ocean.—Chagos, Seychelles (Walker); 3° N.–38° S., 24½°–111° E. (Stephensen); Red Sea (Cecchini).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Gen. *Streetsia* Stebb.

Spandl, 1927, p. 184.

Streetsia challengeri Stebb.

Walker, 1909*a*, p. 55.
Stephensen, 1925, p. 194, fig. 75.
Barnard, 1930, p. 435, and 1932, p. 295.

Occurrence :

St. 61 (day, 1136 metres wire out). Northern Arabian Sea. 1 ♀ 16 mm.
St. 61 (day, 1702 metres wire out). 1 ♀, with embryos, 16 mm.
St. 61 (day, 2265 metres wire out). 1 ♀ 17 mm.
St. 61 (night, 1133 metres wire out). 1 ♂ and 3 ♀♀ (2 ovig.) 14 mm.
St. 61 (night, 1702 metres wire out). 1 ♂ 11·5 mm., 3 ♀♀ 10, 11, 14 mm.
St. 172 (820 metres wire out). Central Arabian Sea. 1 ♀ 11 mm.
St. 186. Gulf of Aden. 1 ♀ 17 mm.

Recorded Localities in Indian Ocean.—Chagos, Seychelles (Walker).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Streetsia porcellus (Claus).

Stephensen, 1925, p. 192.
Spandl, 1927, p. 188, figs. 20, 21 (*intermedius*).
Barnard, 1932, p. 295.

Occurrence :

St. 61 (night, 1133 metres wire out). Northern Arabian Sea. 1 ♀ 9·5 mm.

St. 61 (night, 1702 metres wire out). 1 ♂ 10 mm., 1 ♀ 8·5 mm., 1 ♀, with embryos, 9·5 mm.

Recorded Locality in Indian Ocean.—Zanzibar (Claus).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Gen. *Glossocephalus* Bov.

Bovallius, 1887 (Bih. K. Sv. Vet. Ak. Handl. xi), p. 35 (quoted from next reference).
,, 1890, p. 105.
Giles, 1888, p. 250 (*Elsia*).

Glossocephalus milne-edwardsi Bov.

Giles, 1888, p. 249, pl. 6, figs. 2–4 (♀) (*Elsia indica*).
Walker, 1904, p. 237, pl. 1, fig. 2 (♂♀) (*Elsia indica*).
Spandl, 1927, p. 196, fig. 24.
Cecchini, 1929, p. 9, pl. 4.
Barnard, 1932, p. 131.

Occurrence :

St. 39. Gulf of Aden. 1 ♂ 13 mm.

Recorded Localities in Indian Ocean.—Bay of Bengal (Giles); Ceylon (Walker); 7°–2° S. 80°–90° E. (Bovallius); Red Sea (Cecchini).

Distribution.—Mediterranean, Tropical Atlantic.

Gen. *Rhabdosoma* Ad. & White.

Spandl, 1927, p. 207.
Cecchini, 1929, p. 11.

Rhabdosoma whitei Bate.

Giles, 1887, p. 219, pl. 4 (*investigatoris*).
Walker, 1909*a*, p. 55.
Stephensen, 1925, p. 207.
Cecchini, 1929, p. 11, pl. 5.
Barnard, 1932, p. 296.

Occurrence :

St. 7. Red Sea. 2 ♀♀ and 1 ovig. ♀ *ca.* 40 mm.

St. 61 (day, 566 metres wire out). Northern Arabian Sea. 1 ♂ mutilated, 1 ♀ 23 mm.

St. 61 (night, 1702 metres wire out). 1 ♀, with embryos, *ca.* 45 mm.

St. 76. Gulf of Oman. 1 juv. ♂ 20 mm.

St. 186. Gulf of Aden. 1 ♂ 36 mm.

Recorded Localities in Indian Ocean.—Bay of Bengal (Giles); Seychelles (Walker); Southern Indian Ocean and East Indies (Stephensen); Red Sea (Cecchini).

Distribution.—Atlantic, Indo-Pacific.

Gen. *Leptocotis* Streets.

Stephensen, 1925, p. 191.
Barnard, 1930, p. 434.

Leptocotis tenuirostris (Claus).

Walker, 1909*a*, p. 55.
Stephensen, 1925, p. 191, fig. 74 (synonymy).
Barnard, 1930, p. 435 (synonymy), and 1932, p. 296.

Occurrence :

St. 61 (night, 1136 metres wire out). Northern Arabian Sea. 2 ♀♀ (1 ovig.), 9–10 mm.

St. 186 (1150 metres wire out). Gulf of Aden. 1 ♂ 9 mm.

Recorded Localities in Indian Ocean.—3° 31′ S. 72° 27′ E., 4° 48′ S. 67° 22′ E., Chagos, and Mauritius (Walker).

Distribution.—Atlantic; Gilolo, East Indies; Pacific, 29° N. 36° S.

Family Platyscelidæ.

Gen. *Platyscelus* Bate.

Spandl, 1927, p. 227.

Platyscelus ovoides (Claus).

Walker, 1909*a*, p. 54 (*Eutyphis o.*).
Stephensen, 1925, p. 213.
Spandl, 1927, p. 228, fig. 44.

Occurrence :

St. 108. Gulf of Aden. 1 ♀ with embryos 18 mm.

St. 119. Gulf of Aden. 2 ♀♀ 20 mm. (1 ovigerous and 1 with embryos 1·6 mm. in length).

St. 121. Gulf of Aden. 2 ♀♀ with embryos 17 mm.

Recorded Localities in Indian Ocean.—Seychelles (Walker), 27° 40′ S. 58° 30′ E. (Stephensen).

Distribution.—Mediterranean, Atlantic, Indo-Pacific.

Platyscelus armatus Stebb.

Walker, 1909*a*, p. 53.
Spandl, 1927, p. 229, fig. 45.

Occurrence :

St. 172. Central Arabian Sea. 1 ovig. ♀ 18 mm. (epimera not angularly projecting).

Recorded Locality in Indian Ocean.—Seychelles (Walker).

Distribution.—Warm seas (Spandl).

Platyscelus inermis (Claus).

Barnard, 1932, p. 298.

Occurrence :

St. 5. Red Sea. 1 ♀, with embryos, 11 mm.

Remarks.—See comments in the "Discovery" report. Lower margin of 6th joint of gnathopods 1 and 2 serrated for its entire length as in Stebbing's figures of *armatus* (1888, pl. 182), not merely at apex as in Spandl's figures of *armatus* (1927, p. 230, fig. 45).

Recorded Locality in Indian Ocean.—Mozambique (Claus).

Distribution.—Atlantic

Gen. *Hemityphis* Claus.

Spandl, 1927, p. 233.

Hemityphis crustulum Claus.

Walker, 1909*a*, p. 53 (*crustulatus* typ. err.).
Spandl, 1927, p. 236, fig. 47.
Barnard, 1930, p. 37 (*rapax*, M. Edw.).

Occurrence :

St. 61 (night, 1133 metres wire out). Northern Arabian Sea. 1 ♂ 5 mm., 1 ♀, with embryos, 4·5 mm.

St. 61 (night, 1702 metres wire out). 5 ♀♀ (3 ovig.) 4–4·5 mm.

Remarks.—The 2nd joint of gnathopod 1 is expanded in the middle in ♀ (as in Spandl's figure), but in the ♂ is bottle-shaped, slender proximally, expanding distally.

Recorded Localities in Indian Ocean.—Zanzibar (Claus); Chagos, Seychelles (Walker).

Distribution.—Warm and temperate seas (if only the one species *rapax* be recognized). East Indies.

Gen. *Tetrathyrus* Claus.

Spandl, 1927, p. 240.
Barnard, 1930, p. 439.

Tetrathyrus forcipatus Claus.

Spandl, 1924, and 1927, p. 240, fig. 48.
Barnard, 1930, p. 439.
Pirlot, 1930, p. 42, fig. 11.

Occurrence :

St. 61. Northern Arabian Sea. 1 ♂ 6 mm.

Recorded Locality in Indian Ocean.—Red Sea (Spandl).

Distribution.—Mediterranean, Atlantic, East Indies.

Gen. *Paratyphis* Claus.

Barnard, 1930, p. 438.
Pirlot, 1930, p. 39 (key to species).

Paratyphis maculatus Claus.

Stephensen, 1925, p. 223, fig. 86.
Pirlot, 1930, p. 39.

Occurrence :

St. 186. Gulf of Aden. 1 ♂ 4·5 mm., 4 ♀♀ 3·5–4·5 mm., 1 ovig. ♀ 5·5 mm.

Remarks.—Resembles Spandl's figures of *maculatus*, but peræopod 5 is slender as in Stephensen's figure of *clausii*.

Distribution.—Atlantic, East Indies.

Paratyphis parvus Claus.

Barnard, 1930, p. 439.

Occurrence :

St. 172 (510 metres wire out). Central Arabian Sea. 1 ♀ 3·5 mm.

Remarks.—The process of 5th joint of gnathopod 2 is apically acute and serrate on its lower margin distally. Peræopod 5 narrow, without trace of apical rudimentary joint. Outer ramus of uropod $3\frac{2}{3}$ length of inner ramus.

Distribution.—Atlantic, New Zealand.

Gen. *Amphithyrus* Claus.

Barnard, 1930, p. 438.
Pirlot, 1930, p. 43.

Amphithyrus bispinosa Claus.

Stephensen, 1925, p. 225.
Spandl, 1927, p. 247, fig. 50.
Barnard, 1930, p. 438.

Occurrence :

St. 61 (night, surface). Northern Arabian Sea. 29 ♀♀ (some ovig.) 3–4 mm.

St. 172 (510 metres wire out). Central Arabian Sea. 1 ♂ 3 mm.

St. 186 (510 metres wire out). Gulf of Aden. 1 ♂ 3 mm.

Recorded Locality in Indian Ocean.—Bay of Bengal (Stephensen).

Distribution.—Atlantic, Mediterranean, East Indies, Pacific.

Amphithyrus sculpturatus Claus.

Claus, 1887, p. 41, pl. 7, figs. 1–9.
Stebbing, 1888, p. 1485, pl. 210, fig. B (*orientalis*).
Shoemaker, 1925 (Bull. Amer. Mus. Nat. Hist., lii), p. 58, figs. 25, 26 (*orientalis*).
Stephensen, 1925, p. 226.
Spandl, 1927, p. 250.

Occurrence :

St. 96. Central Arabian Sea. 1 ♀ 5 mm.

Remarks.—The last peræopod bears 2 rudimentary joints at the end of the 2nd joint, as in *inermis* (Spandl, p. 250, key to species), but the whole integument is strongly sculptured. As remarked under *glaber* (Barnard, 1930, p. 438), I do not think that a limb subject to reduction is a very reliable guide in differentiating species. The single specimen is therefore assigned to *sculpturatus*, of which *orientalis* seems to be a synonym.

Distribution.—*sculpturatus* : Atlantic and Mediterranean. *orientalis :* Pacific (Stebbing), Gulf of California (Shoemaker).

Family Thyropidæ.

Gen. *Thyropus* Dana.

Spandl, 1927, p. 258.

Thyropus sphæroma Claus.

Spandl, 1927, p. 259, figs. 53, 54, and p. 284, fig. 63.
Pirlot, 1930, p. 36.

Occurrence :

St. 61 (night, surface). Northern Arabian Sea. 19 ♂♂ 5–5·5 mm

St. 61 (night, 1702 metres wire out). 1 ♂ 4·5 mm.

Distribution.—Tropical Atlantic, East Indies.

CAPRELLIDEA.

Family Caprellidæ.

Gen. *Caprella* Lam.

Mayer, 1903, pp. 14, 72.

Caprella danilevskii Czern.

Barnard, 1916, p. 280.

Occurrence :

St. MB II A. South Arabian coast. 1 immature ♂ 8·5 mm., 1 juv. 5 mm.

Distribution.—Bay of Biscay, Mediterranean, Black Sea ; Bermuda ; Rio de Janeiro ; South Africa ; Port Jackson, Australia ; Japan.

Gen. *Paradeutella* Mayer.

Mayer, 1890, p. 29, and 1903, p. 45.
Schellenberg, 1928, p. 676.

Remarks.—The genus is entirely Indo-Pacific, comprising the following species : *echinata* (Hasw.), New South Wales, *bidentata* Mayer, Ceylon, *lævis* Mayer, *armata* Mayer, and *spinosa* Mayer, Singapore, *multispinosa* Schell., Suez, and *serrata* Mayer, South Africa.

Paradeutella bituberculata n. sp.

Occurrence :

St. 45. South Arabian coast. 1 ♂ 5 mm.

Description.—Head with one medio-dorsal upstanding, slightly forwards curving, spine ; posterior margins of peræon segments 1 and 2 each with a medio-dorsal conical tubercle, peræon segments 3 and 4 each with a low medio-dorsal tubercle on both anterior and posterior margins ; peræon segment 2 with a *pair* of subdorsal conical tubercles opposite the insertion of the 2nd gnathopods. A lateral spine above insertion of 2nd gnathopods and the gills on segments 3 and 4.

Peduncle of antenna 1 without tubercles or projections.

Gnathopod 2, 2nd joint with tooth on antero-exterior margin distally, a similar tooth

on 3rd joint, 4th subglobular below, 6th as in *echinata* (see Mayer, 1890, pl. 3, fig. 42), the defining angle not prominent, the squarish tooth (Gleithöcker) near the hinge bidentate. Gills ovate with slender peduncles. Rudiments of peræopods not traceable.

Remarks.—The paired tubercles on the 2nd peræon segment are distinctive, and although *armata* Mayer has a pair of spines on this segment, the other characters do not quite fit for this latter species.

Gen. *Monoliropus* Mayer.

Mayer, 1903, p. 53.

Monoliropus falcimanus Mayer.

Mayer, 1904, p. 225, fig. 1.

Occurrence :

St. 45. South Arabian coast. 2 ♂♂ 9·5 and 12 mm., 5 ♀♀ 8–10·5 mm., 2 ovig. ♀♀ 3·5 and 9 mm., 1 juv. ♀ 3 mm.

Remarks.—The rudiments of the peræopods at the bases of the gills on segments 3 and 4 are extraordinarily minute and difficult to detect. The difference in size of the two ovigerous ♀♀ is interesting, but not unusual in the *Caprellidæ*.

This species is very close to *agilis* from Siam, and may prove to be merely the adult of that species.

Recorded Locality in Indian Ocean.—Ceylon.

Gen. *Hemiægina* Mayer.

Mayer, 1890, p. 40, and 1903, p. 65.
Raj, 1927, p. 126.

Hemiægina ? minuta Mayer.

Mayer, 1890, p. 40, pl. 1, figs. 25–27 ; pl. 3, figs. 32–35 ; pl. 5, figs. 52, 53 ; pl. 6, figs. 13, 33, 34 ; pl. 7, fig. 4 ; and 1903, p. 65, pl. 6, fig. 72.

Occurrence :

St. Extra. South Arabian coast. 1 ♂ 4·5 mm.

Remarks.—Unfortunately the specimen has lost both 2nd gnathopods, so that it is impossible to say whether it belongs to the typical form or to the Ceylon form with a squarish notch on the palm, which Raj regards as a separate species (Raj, *l. c.*, p. 126, pl. 18, *quadripunctata*).

Recorded Locality in Indian Ocean.—Ceylon (Raj).

Distribution.—Amoy, 8–25 fathoms (Mayer) ; 1° 42′ S. 130° 47′ E., 32 metres (Mayer).

LIST OF LITERATURE.

(Includes papers listed more than once in the Systematic part, and also some which have an important bearing on the Amphipodan fauna of the region under discussion.)

Barnard, K. H. 1916. Contributions to the Crustacean Fauna of South Africa. No. 5: Amphipoda. Ann. S. Afr. Mus. XV, pp. 105–302, pls. 26–28.

—— 1925. Contributions to the Crustacean Fauna of South Africa. No. 8: Further Additions to the List of Amphipoda. Ann. S. Afr. Mus. XX, pp. 319–380, pl. 34.

—— 1930. Amphipoda. British Antarctic ("Terra Nova") Expedition, 1910, Zool. VIII, No. 4, pp. 307–454, text-figs. 1–63.

—— 1931. Amphipoda. Great Barrier Reef Expedition, IV, pp. 111–135, 4 text-figs.

—— 1932. Amphipoda. "Discovery" Reports, V, pp. 1–326, pl. 1, and 174 text-figs. (August).

—— 1935. Report on some Amphipoda . . . in the Collections of the Indian Museum. Rec. Ind. Mus. XXXVII, pp. 279–319, text-figs.

Bovallius, C. 1887. Contributions to a Monograph of the Amphipoda Hyperiidea. Part I. 1. The Families Tyronidæ, Lanceolidæ and Vibiliidæ. Kongl. Svensk. Vet. Ak. Handl. XXI, 5, pp. 1–72, pls. 1–10.

—— 1889. Contributions to a Monograph of the Amphipoda Hyperiidea. Part I. 2. The Families Cyllopodidæ, Paraphronimidæ, Thaumatopsidæ, Mimonectidæ, Hyperiidæ, Phronimidæ and Anchylomeridæ. Kongl. Svensk. Vet. Ak. Handl. XXII, 7, pp. 1–434, pls. 1–18.

—— 1890. The Oxycephalids. Nov. Act. Reg. Sc. Upsala, ser. 3, pp. 1–141, text-figs. and pls. 1–7.

Cecchini, C. 1929. Oxicefalidi del Mar Rosso. Ist. Idrogr. Reg. Mar. Ann. Idrogr. XI, *bis*, pp. 1–16, 6 pls.

Chevreux, E. 1900. Amphipodes provenant des campagnes de "l'Hirondelle". Res. Camp. Sci. Monaco, fasc. 16, pp. i–iv, 1–195, pls. 1–18.

—— 1901. Amphipodes, Mission . . . Alluaud aux Iles Seychelles. Mem. Soc. Zool. Francc, XIV, pp. 388–438, text-figs. 1–65.

—— 1907. Amphipodes recueillis dans . . . l'Océanie par M. Seurat. Mem. Soc. zool. Francc, XX, pp. 470–527, text-figs. 1–35.

—— and Fage, L. 1925. Amphipodes. Faune de France, pp. 1–488, text-figs.

Chilton, C. 1921. Amphipoda. Fauna of the Chilka Lake. Mem. Ind. Mus. V, pp. 520–558, 12 text-figs. (May).

—— 1921*a*. Report on the Amphipoda Obtained by the F.I.S. "Endeavour" in Australian Seas. Biol. Res. "Endeavour", V, pp. 33–92, text-figs. (September 23rd).

—— 1923. Occasional Notes on Australian Amphipoda. Rec. Austr. Mus. XIV, pp. 79–100, 5 text-figs.

—— 1925. The Amphipoda of Talé Sap. Mem. Asiat. Soc. Beng. VI, pp. 531–558, 3 text-figs. (November).

Claus, C. 1887. Die Platysceliden. Wien, pp. 1–75, pls.

Della Valle, A. 1893. Gammarini. Fauna and Flora des Golfes von Neapel, XX, text and atlas.

Giles, G. M. 1885. On the Structure and Habits of *Cyrtophium calamicola*. J. Asiat. Soc. Beng. LIV, pp. 54–59, pl. 1.

—— 1885*a*. Description of a New Species of the Amphipod Genus *Melita*. J. Asiat. Soc. Beng. LIV, pp. 60–71.

—— 1887. On Six New Amphipods from the Bay of Bengal. J. Asiat. Soc. Beng. LVI, pp. 212–229, pls. 3–8 (published November 2nd).

—— 1888. Further Notes on the Amphipoda of Indian Waters. J. Asiat. Soc. Beng. LVII, pp. 220–255, pls. 6–12.

—— 1890. Descriptions of Seven Additional New Indian Amphipods. J. Asiat. Soc. Beng. LIX, pp. 63–74, pl. 2.

Gravely, F. H. 1927. Amphipoda of Krusadai Island, Gulf of Manaar. Bull. Madras Govt. Mus. n.s. I, pp. 123–124.

Kossmann, R. 1880. Zoologische Ergebnisse einer . . . Reise in die Küstengebiete des Rothen Meeres. 2te Hälfte, Hft. 1, Leipsic. (*See* Stebbing, 1888, p. 515.)

Mayer, P. 1890. Nachtrag zu den Caprelliden. Fauna u. Flora des Golfes von Neapel, Monogr. XVII, pp. 1–157, pls. 1–7.

Mayer, P. 1903. Die Caprellidæ der Siboga-Expedition. Siboga Exp. Monogr. XXIV, pp. 1–160, pls. 1–10.

—— 1904. Report on the Caprellidæ Collected by Prof. Herdman, at Ceylon, in 1902. Ceyl. Pearl Oyster Fish. Suppl. Rep. XVI, pp. 223–228, 9 text-figs.

Miers, E. J. 1884. Crustacea. Pt. 1. From Melanesia, pp. 178–322, pls. 18–34. Pt. 2. From the Western Indian Ocean, pp. 513–682, pls. 46–52. Rep. Zool. Coll. H.M.S. " Alert ", Brit. Mus., London.

Pirlot, J. M. 1929. Les Amphipodes Hypérides. Rés. zool. Crosière Atl. de l' " Armauer Hansen ". Trav. Inst. Ed. van Beneden, Liége, fasc. 1, pp. 1–196, text-figs. 1–8.

—— 1929*a*. Les Amphipodes Gammarides. Trav. Inst. Ed. van Beneden, Liége, fasc. II, pp. 1–18, text-figs. 1–3.

—— 1930. Les Amphipodes de l'Expedition du Siboga. Pt. I. Hyperides (excl. Thaumatopsidæ et Oxycephalidæ). Siboga Exp. Monogr. XXXIII *a*, pp. 1–55, text-figs. 1–11.

—— 1932. Les Amphipodes de l'Expedition du Siboga. Pt. II. Amphipodes fouisseurs, Phoxocephalidæ, Œdicerotidæ. Siboga Exp. Monogr. XXXIII *b*, pp. 57–113, text-figs. 12–34 (February).

—— 1933. Les Amphipodes de l'Expedition du Siboga. Pt. II (2). Les Amphipodes de la mer profonde, 1. Siboga Exp. Monogr. XXXIII *c*, pp. 115–167, text-figs. 35–60.

—— 1934. Les Amphipodes de l'Expedition du Siboga. Pt. II (2). Les Amphipodes de la mer profonde, 2. Siboga Exp. Monogr. XXXIII *d*, pp. 167–235, text-figs. 61–100.

—— 1936. Les Amphipodes de l'Expedition du Siboga. Pt. II (2, 3). Les Amphipodes de la mer profonde, 3. Les Amphipodes littoraux, 1. Siboga Exp. Monogr. XXXIII *e*, pp. 237–328, text-figs. 101–146.

Raj, B. S. 1927. Caprellidea of Krusadai Island, Gulf of Manaar. Bull. Madras Govt. Mus. n.s. I, pp. 125–128, pls. 15–18.

Sars, G. O. 1891–1895. An Account of the Crustacea of Norway. I. Amphipoda. Text and plates.

Schellenberg, A. 1925. Amphipoda. Beitr. Kennt. Meeresf. Westafr. III, Lf. 4, pp. 113–204, text-figs.

—— 1926. Die Gammariden der Deutschen Südpolar-Expedition 1901–1903. Deutsch. Südpol.-Exp. XVIII, Zool. X, pp. 235–414, text-figs. (Received in Brit. Mus. library, June 18th, 1926.)

—— 1926*a*. Die Gammariden der Deutschen Tiefsee-Expedition. Wiss. Erg. D. Tiefsee-Exp. " Valdivia ", XXIII, Hft. 5, pp. 195–243, text-figs. and pl. 5.

—— 1928. Amphipoda, Cambridge Expedition to Suez Canal. Trans. Zool. Soc. Lond. XXII, pp. 633–692, text-figs. 198–209.

Shoemaker, C. R. 1935. The Amphipods of Porto Rico and the Virgin Islands. New York Ac. Sci. XV, pp. 229–253, 5 text-figs.

Spandl, H. 1924. Die Amphipoden des Roten Meeres in Expedition S.M. Schiff " Pola " in das Rote Meer 1895–1898. Denkschr. Ak. Wiss. Wien, XCIX, pp. 19–73, text-figs., maps.

—— 1927. Die Hyperiden (exkl. Hyperiidea, Gammaroidea und Phronimidæ) der Deutschen Südpolar-Expedition, 1901–1903. Deutsch. Südpol.-Exp. XIX, Zool. XI, pp. 147–287, text-figs. and 1 chart (pl. 10).

Stebbing, T. R. R. 1888. Report on the Amphipoda Collected by H.M.S. " Challenger " during the years 1873–1876. Rep. Sci. Res. Voy. " Challenger ", XXIX, text and plates.

—— 1897. Amphipoda from the Copenhagen Museum and other Sources. Trans. Linn. Soc. Lond. 2 ser., zool. VII, pp. 25–45, pls. 6–14.

—— 1906. Amphipoda Gammaridea. Das Tierreich, Lief. XXI, pp. i–xxxix, 1–806, text-figs.

—— 1908. South African Crustacea. Pt. 4. Ann. S. Afr. Mus. VI, pp. 1–96, pls. 1–14 (Crust. pls. 27–40).

—— 1910. Amphipoda. Scientific Results of the Trawling Expedition of H.M.C.S. " Thetis ". Mem. Austr. Mus. IV, pp. 567–658, pls. 47*–60* (July).

—— 1910*a*. General Catalogue of South African Crustacea. Ann. S. Afr. Mus. VI, pt. 4, pp. 281–593, pls. 15–22 (Crust., pls. 41–49) (December).

—— 1918. Some Crustacea of Natal. Ann. Durban Mus. II, pp. 47–75, pls. 8–12.

Stephensen, K. 1915. Isopoda . . . Amphipoda (excl. Hyperiidea). Danish Ocean. Exp. 1908–1910 to Mediterranean and Adjacent Seas, II, D 1, pp. 1–53, text-figs.

—— 1918. Hyperiidea-Amphipoda (Lanceolidæ, Scinidæ, Vibiliidæ, Thaumatopsidæ). Dan. Ocean. Exp. 1908–1910 to Mediterranean and Adjacent Seas, II, D 2, pp. 1–70, text-figs. (*See* note in Barnard, 1932, p. 318.)

—— 1924. Hyperiidea-Amphipoda (Pt. 2 : Paraphronimidæ, Hyperiidæ, Dairellidæ, Phronimidæ, Anchylomeridæ). Dan Ocean Exp. 1908–1910 to Mediterranean and Adjacent Seas, II, D 4, pp. 71–149, text-figs.

Stephensen, K. 1925. Hyperiidea-Amphipoda (Pt. 3 : Lycæopsidæ, Pronoidæ, Lycæidæ, Brachyscelidæ, Oxycephalidæ, Parascelidæ, Platyscelidæ). Dan. Ocean. Exp. 1908–1910 to Mediterranean and Adjacent Seas, II, D 5, pp. 150–252, text-figs. (December).

—— 1931. Amphipoda. Rés. Sci. Ind. Orient. Néerland. III, 4, pp. 1–14, 3 text-figs. (Mem. Mus. Roy. d'Hist. Nat. Belg.).

—— 1932. Some New Amphipods from Japan. Annot. Zool. Jap. XIII, pp. 487–501, text-figs. 1–5.

—— and Pirlot, J. M. 1931. Les Amphipodes Hypérides du Genre Mimonectes Bov., et de quelques Genres voisins. Arch. Zool. Exper. Gen. LXXI, pp. 501–553, text-figs.

Tattersall, W. M. 1922. Amphipoda with Notes on an Additional Species of Isopoda. Mem. Asiat. Soc. Beng. VI, pp. 435–459, pls. 18–21 (April).

—— 1922*a*. The Percy Sladen Trust Expeditions to the Abrolhos Islands (Indian Ocean). Amphipoda and Isopoda. Journ. Linn. Soc. Lond. Zool. XXXV, pp. 1–19, pls. 1–3 (June).

Vosseler, J. 1901. Die Amphipoden der Plankton-Expedition, I. Hyperiidea I. Erg. Plankton-Exp. II, G.e. pp. i–viii, 1–129, text-figs. and pls. 1–13.

Wagler, E. 1926. Amphipoda 2 : Scinidæ. Wiss. Ergebn. Deutsch. Tiefsee-Exp. " Valdivia ", XX, 6, pp. 317–446, text-figs.

Walker, A. O. 1904. Report on the Amphipoda Collected by Professor Herdman, at Ceylon, in 1902. Ceyl. Pearl Oyster Fish. Suppl. Rep. XVII, pp. 229–300, pls. 1–8.

—— 1905. Amphipoda. Fauna and Geography, Maldive and Laccadive Archipelagos, II, pp. 923–932, pl. 88 and 3 text-figs.

—— 1909. Amphipoda Gammaridea from the Indian Ocean, British East Africa, and the Red Sea. Trans. Linn. Soc. Lond. 2 ser., zool. XII, pp. 323–344, pls. 42, 43.

—— 1909*a*. Amphipoda Hyperiidea of the " Sealark " Expedition to the Indian Ocean. Trans. Linn. Soc. Lond. 2 ser., Zool. XIII, 1, pp. 49–55.

—— and Scott, A. 1903. Crustaceans from Abd-el-Kuri. Nat. Hist. Sokotra (Amphipoda), pp. 219–232, pls. 14 A, 14 B.

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BY

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INTRODUCTION.

IT is certainly very astonishing that a region so much frequented as the Arabian Sea is still unexplored with regard to animals so large and striking as the Scyphomedusæ. Prior to the John Murray Expedition no other expedition has explored these waters, though occasionally records have been given of large medusæ from this part of the Indian Ocean. Our knowledge of the medusæ of the Arabian Sea is mainly due to E. T. Browne, who

reported on collections from the Maldives and Laccadives (1905), the Pearl Oyster Banks of Manaar (1905), the Okhamandal coast of Kattiawar (1916), and of the " Sealark " from the southern parts of the Arabian Sea (1916). Bigelow (1901–4) has given a short report on a collection from the Maldives. More extensive is the memoir of Vanhoeffen (1903) on the collections of the " Valdivia " ; the Deutsche Tiefsee Expedition, however, examined this part of the Indian Ocean somewhat superficially. Chun (1896) has described some new medusæ from the waters off Zanzibar. But this is the full extent of our knowledge. It is, therefore, easily understood that, although in the catches of the John Murray Expedition there are no new forms and the number of species collected is not large, the material gathered in an area so poorly explored is important from the point of view of geographical distribution.

The western part of the Indian Ocean has been much better explored with regard to the Scyphomedusæ than the eastern part. Here the medusan fauna of Madras, Calcutta and the Malayan Archipelago has recently been studied respectively by Menon, Rao and the author himself, and long lists of Scyphomedusæ have been recorded from these waters.

I give below a list of the species collected by the John Murray Expedition :

	Number of specimens.
Order CHARYBDEIDÆ :—	
Family CHARYBDEIDÆ :	
Tamoya alata Reynaud*	4
Family CHIRODROPIDÆ :	
Chiropsalmus quadrigatus Haeckel*	1
Order CORONATÆ :—	
Family PERIPHYLLIDÆ :	
Periphylla hyacinthina Steenstrup	237
Family ATOLLIDÆ :	
Atolla wyvillei Haeckel	33
Family NAUSITHOIDÆ :	
Nausithoë punctata Kölliker	1
Order SEMÆOSTOMEÆ :—	
Family PELAGIDÆ :	
Pelagia noctiluca Forskål	115
Sanderia malayensis Goette	6
Family ULMARIDÆ :	
Aurelia maldivensis Bigelow	9
Order RHIZOSTOMÆ :—	
Family CEPHEIDÆ :	
Cephea sp.	2
Netrostoma cœrulescens Maas*	1
Family CATOSTYLIDÆ :	
Crambionella orsini (Vanh.) Stiasny*	17
Total	426

* A new record for the Arabian Sea.

In addition the following stages of development (young and older ephyræ and later stages) were sorted out from the plankton samples :

Pelagia noctiluca Forskål	10 specimens.
Periphylla hyacinthina Steenstrup	1 specimen.
Sanderia malayensis Goette	27 specimens.

Of the 426 specimens caught more than half are referable to *Periphylla hyacinthina* (237 specimens in all ; 86 from Station 35, 59 from Station 186, and 55 from Station 193). Then follows in respect of numbers *Pelagia noctiluca* with 115 specimens (69 specimens from Station 87). Many fewer specimens were caught of *Atolla wyvillei* (33) and *Crambionella orsini* (17). The remaining species are represented in the catches by a few specimens only.

The following forms are remarkable :

Chiropsalmus quadrigatus : The single complete specimen, although its different organs are partially torn away or removed, was available for a more thorough study of the anatomy of this rare medusa, especially of the gastric pouches, than has been made previously.

Sanderia malayensis : Besides some very beautiful adult specimens, several young stages of development could be studied, these being the first stages of development of this medusa that have ever been recorded.

Crambionella orsini : This species, represented in the catches by numerous well-preserved specimens with fresh colours, could be studied with regard to variation of coloration and be compared with the other known species of this genus. In this case I have been able to settle certain systematic questions.

The importance of the present collection becomes evident by a comparison of the lists of the previous records of Scyphomedusæ in the Indian Ocean and the Arabian Sea with the list of the medusæ caught by the John Murray Expedition.

Previous Records of Scyphomedusæ in the Indian Ocean.*

Chun (1896), from Zanzibar :—

Pelagia panopyra Pér. and Les.
Aurelia colpota Brandt.
Crambessa stuhlmanni Chun.
C. viridescens Chun.
Mastigias siderea Chun.
Cassiopea andromeda var. *zanzibarica* Chun.

Bigelow (1901–04) from the Maldive Islands :—

Aurelia maldivensis Bigelow.
Nausithoë punctata Kölliker.

Browne (1905*a*) from the Laccadive and Maldive Archipelagoes :—

Pelagia sp.
Aurelia aurita var. *colpota* Brandt.
A. solida Browne.
Cassiopea andromeda var. *maldivensis* Browne.
Netrostoma cœrulescens Maas.

* The names of the species are given here as written in the original communications.

Browne (1905*b*) from the Gulf of Manaar :—

Charybdea sp.
Nausithoë punctata Kölliker.
Pelagia sp.
Crambessa sp.

Browne (1916*b*), from the Okhamandal Coast, Kattiawar :—

Cassiopea andromeda var. *maldivensis* Browne.

Browne (1916*a*), from the "Sealark" collection, between Chagos, Mauritius and the Seychelles :—

Charybdea sp.
Nausithoë punctata Kölliker.
Atolla wyvillei Haeckel.
Pelagia panopyra Pér. and Les.
P. flaveola Eschscholtz.
Pelagia sp.
Cassiopea andromeda var. *maldivensis* Browne.

Vanhoeffen (1903), from the collection of the "Valdivia" Expedition :—

**Atolla verrilli* Fewkes . . .	Indian Ocean.
**A. valdiviæ* Vanhoeffen . . .	Indian Ocean.
Periphylla regina Haeckel . .	Indian Ocean (tropical parts).
P. dodecabostrycha Brandt . .	Indian Ocean.
P. hyacinthina Steenstrup . .	Coast of Somaliland.
Periphyllopsis braueri Vanhoeffen .	Between New Amsterdam and Cocos Island.
Nausithoë punctata Kölliker . .	Gulf of Aden and East of Ceylon.
N. rubra Vanhoeffen . . .	West of Ceylon.
Palephyra indica Vanhoeffen . .	†Gulf of Aden.
Atorella subglobosa Vanhoeffen . .	†Between Seychelles and Dar es Salaam.
Pelagia phosphora Haeckel . .	Between Ceylon and East Africa.
Sanderia malayensis Goette . .	Gulf of Aden.
Chrysaora fulgida Reynaud . .	Algoa Bay.
Poralia rufescens Vanhoeffen . .	Between Koningin Emma haven and Siberut.
Aurelia aurita Linn. . . .	†Koningin Emma haven, between Maldives and Chagos islands, near the coast of Somaliland and the Red Sea.
Cephea cœrulea Vanhoeffen . .	Dar es Salaam.
Mastigias papua Lesson . . .	Koningin Emma haven.

Very much richer are the lists given by Menon of species from Madras and by Rao of the "Investigator" collections from the Bay of Bengal and the Laccadive Sea.

Menon (1930), from Madras :—

Charybdea madraspatana Menon.
Tamoya sp.
Chiropsalmus buitendyki Horst.

* *Atolla verrilli* and *valdiviæ* are synonyms for *A. wyvillei*; for localities see the Map.
† Not indicated in the Map.

Nausithoë punctata Kölliker.
Pelagia noctiluca Pér. and Les.
Dactylometra quinquecirrha Agass.
Cyanea purpurea Kishinouye.
Aurelia solida Browne.
Cassiopea andromeda var. *malayensis* Maas.
Cephea sp.
Netrostoma cœrulescens Maas.
N. setouchianus Kishinouye.
Mastigias albipunctata Stiasny.
Lorifera lorifera (Haeckel).
Lychnorhiza malayensis Stiasny.
Crambionella orsini (Vanh.) Stiasny.
C. stuhlmanni (Chun).
Acromitus flagellatus (Haeckel).
Lobonema mayeri Light.
Lobonemoides robustus Stiasny.
Rhopilema hispidum Maas.

Rao (1931), from the coasts of India and Burma :—

Periphylla hyacinthina Steenstrup.
Atolla wyvillei Haeckel.
Tamoya alata Reynaud.
Tamoya sp.
Chiropsalmus quadrumanus Agass.
Pelagia noctiluca Forskål.
Chrysaora helvola Brandt.
Cyanea capillata var. *nozakii* Kishinouye.
Aurelia aurita Lam.
A. solida Browne.
Cassiopea (?) *frondosa* (Pallas) Lam.
C. andromeda var. *maldivensis* Browne.
Netrostoma typhlodendrium Schultze.
Mastigias occellata (Modeer).
M. albipunctata Stiasny.
M. papua var. *sibogæ* Maas.
Mastigias sp.
Versura anadyomene (Maas).
Thysanostoma thysanura (Haeckel).
Acromitus flagellatus (Haeckel).
A. rabanchatu Annandale.
Crambionella annandalei Rao.
Lobonema smithii Mayer.
Lobonemoides sewelli Rao.
Rhopilema hispidum Maas.

From the above lists we see that certain species have been caught by the John Murray Expedition in the Arabian Sea that are new for the fauna of this region (viz. *Tamoya*

alata, *Chiropsalmus quadrigatus*, *Netrostoma cœrulescens* and *Crambionella orsini*), and that, on the contrary, many very typical forms, recorded very regularly from the waters of the eastern half of the Indian Ocean, are not represented in the collection. We miss in the first place such very common medusæ as *Dactylometra quinquecirrha*, *Mastigias papua*, *Crambione mastigophora* and various species of the genera *Acromitus* and *Catostylus*, all true representatives of the fauna of the Bay of Bengal and the Malayan Archipelago ; and it is a striking fact that in the catches made by the expedition not a single specimen could be found of the very common *Cassiopea andromeda*, that is known from the Red Sea and has been recorded previously in the Arabian Sea from Zanzibar, from Kattiawar and from the waters of the Maldive Archipelago. The absence of this medusa, otherwise so typical for all tropical shallow seas, may perhaps be due to the fact that the western coasts of the Arabian Sea are mostly rocky, that there are often high, vertical or in some places even overhanging cliffs, that there are very few lagoons and mangrove-swamps, and that the shelf in general is very narrow and drops rather abruptly into deep waters.*

Very striking, on the other hand, is the appearance of *Crambionella orsini*, in the Gulf of Oman, this medusa having been found, hitherto, exclusively in the waters off Madras and only once (near Assale) in the Red Sea. It was, therefore, not to be expected in this area.

If we now look at the Chart showing the geographical distribution of the " John Murray " medusæ (Map I), the first impression that we get is that the localities are by no means evenly distributed over the Arabian Sea. We see at a glance that there are two large concentrations of localities, one in the Gulf of Oman and the other in the Gulf of Aden, and two smaller " nests ", one in the waters off Zanzibar and the other near Cape Guardafui. In the eastern and central parts of the Arabian Sea there are very few localities—seven only in the section Bombay–Mombasa. This is, however, not at all surprising ; the open sea is not the proper habitat for these rapacious animals, which, in general, prefer the more nutritive waters of the shores and the mouths of rivers. It is, however, rather astonishing that so few specimens of medusæ were caught in the waters off Zanzibar, near the Maldives and in the south of our area. This may be due to bad weather and heavy seas (monsoon), or to the collecting having been done at the wrong season of the year (*vide* Browne, 1916*b*, p. 151 and footnote ; Sewell, 1935, p. 6 and this report, p. 220). From all these localities previous expeditions collected many more specimens of medusæ than did the John Murray Expedition. As I have shown in my report on the medusæ collected by the " Snellius " Expedition (1935), collections made by expeditions do not always give a good impression of a fauna, and it has occurred more than once that just the most characteristic components of a fauna may be absent from the lists. It is the conviction of the author that several species that were either not collected by the John Murray Expedition at all, or are represented by one or a few specimens only, are more abundantly represented in these waters than the records of their occurrence might indicate, *e. g. Nausithoë*, *Cassiopea*, etc.

Let us consider now the previous records in the two charts given by Vanhoeffen in 1891 and 1909 representing the geographical distribution of the Scyphomedusæ all over the world. We see that in the Arabian Sea there are numerous localities of *Nausithoë punctata*, which is distributed over the whole Indian Ocean, and a few

* It must also be borne in mind that the object of the Expedition was essentially the exploration of the deeper waters, and in consequence the exploration of the plankton, especially that of the upper levels, was omitted from the programme of work to be undertaken.—Editor.

catches of *Periphylla* near Zanzibar and in the Gulf of Aden. (I cannot understand why Vanhoeffen omitted from his map of 1909 the localities of the Scyphomedusæ of the "Valdivia" Expedition, that he himself reported on in 1903.) In my transparent map (Map II), nearly all localities of Scyphomedusæ recorded in the previous reports are represented (with the exception of a few species caught only once in this region). We find in the whole northern part of the Arabian Sea between Arabia and British India the same large empty space as is shown in the charts of Vanhoeffen, with the exception of one single locality (*Cassiopea andromeda*, Browne, 1916). A few catches are recorded from the Gulf of Aden (*Periphylla*, *Atolla*, *Nausithoë*). The central part of the Arabian Sea is entirely empty. Previous localities are, however, abundant in the area between the Laccadives (Minikoi) and the Chagos Archipelago ; here we find recorded numerous catches of *Aurelia*, *Pelagia* and *Nausithoë* in an area where the John Murray Expedition collected almost nothing. There are a few catches between the Seychelles and Zanzibar (*Nausithoë*, *Periphylla* and *Atolla*). The waters off Zanzibar, however, appear to be relatively rich in different species of Scyphomedusæ, but, apart from *Nausithoë* and *Aurelia*, the records are for the most part of a single or very few specimens of very rare species. The John Murray Expedition here collected quite different forms, and particularly remarkable is the chain of localities along the Somali coast to Cape Guardafui of *Pelagia*, *Aurelia*, *Periphylla* and *Atolla*. On the whole we find that the previous localities occur either exclusively in the southern part of the Arabian Sea or are arranged peripherally around the empty central area.

If we observe both maps simultaneously, the progress of our knowledge of the distribution of Scyphomedusæ in the Arabian Sea afforded by the John Murray Expedition becomes evident. Previous records and the localities of the John Murray Expedition form excellent supplements to each other, so that the whole area appears now to have been explored, with the exception, perhaps, of the area between the Laccadives and Bombay, in which we have only a single record of *Periphylla hyacinthina* and two of *Atolla wyvillei*.

The scyphomedusan fauna of the eastern part of the Indian Ocean, and to a still higher degree that of the waters of the Malayan Archipelago, is very much richer. In conformity with the statements made by Ekman (1935, pp. 46–47), it can be said that the further we pass westwards from the Malayan Archipelago with its abundant Scyphomedusæ, the medusan fauna becomes progressively poorer, and its character more and more different.

A comparison of the scyphomedusan fauna of the Arabian Sea with that of the Red Sea is at present almost impossible. It is much to be regretted that the Red Sea must still be regarded as almost unexplored in this respect. The collections of the single large expedition that explored the whole area, namely that of the "Pola", have never been studied and, for the rest, there are but very few records of Scyphomedusæ from this sea (Vanhoeffen described a few medusæ from Assab, and Keller studied the variability of a species of *Cassiopea* from a locality, not indicated, in the southern part of the Red Sea ; all other records are from northern parts [Browne, Haeckel, Mayer and the author]). As far as we know, the main representatives are *Pelagia*, *Aurelia*, *Cassiopea*, *Sanderia*, *Cephea* and *Mastigias*. There is, however, no doubt that the scyphomedusan fauna of the Red Sea is even poorer than that of the Arabian Sea. It is, of course, a great pity that the John Murray Expedition, when passing this region twice, had no opportunity of

collecting here.* I believe, however, that not many medusæ are to be expected in the southern part of the Red Sea. Sewell (1935, p. 8) writes, " at depths greater than that of the entrance channel, namely some 100 metres, there is an almost complete absence of animal life ". This is, however, certainly not the case at the surface.

The material is, on the whole, in a good state of preservation. The specimens of *Sanderia malayensis* are extremely beautiful, and those of *Crambionella orsini* have maintained not only their original shape, but their vivid colours too. The specimens of *Periphylla* and *Atolla*, however, from greater depths, are for the most part deformed and their colours have faded ; I found those in the jars to be almost transparent, lying in a brown fluid, the pigment having dissolved out.

I take the opportunity of expressing my best thanks to Lieut.-Col. R. B. Seymour Sewell, the leader of the expedition, not only for much valuable information and advice, but also for the revision of the text of my manuscript. I am very much obliged to Dr. W. T. Calman, former, and Mr. Martin A. C. Hinton, present Keeper of the Zoological Department, British Museum, London, for the interest they have taken in these studies and for the trouble that both took to facilitate them. My thanks are also due to Mr. H. van der Maaden, Katwyk aan Zee, for his valuable assistance in various respects in preparing this report. Finally, I render my best thanks to Mr. H. Cornet, preparateur aan het Ryksmuseum van Natuurlyke Historie, Leiden, for all his trouble in making the photographs for Plate I of this report.

SYSTEMATIC ACCOUNT

Order CHARYBDEIDEA Poche, 1914.

(= CHARYBDEIDÆ Gegenbaur, 1856, CUBOMEDUSÆ Haeckel, 1879.)

Family Charybdeidæ Haeckel, 1879.

Genus *Tamoya* Fritz Müller 1859.

Tamoya alata (Reynaud). (Text-figs. 1, 2 and 3*a*, *b*.)

References :

Charybdea alata var. *grandis* Agassiz and Mayer, A. G. Mayer, 1910, p. 511.
Tamoya alata Reynaud, T. Uchida, 1929, pp. 172–180, figs. 87–88.
Tamoya alata Reynaud, H. S. Rao, 1931, pp. 27, 28.
Tamoya alata Reynaud, G. Stiasny, 1934, pp. 341, 342.
Tamoya alata Reynaud, G. Stiasny, 1935, pp. 10, 11.

Occurrence :

1. Station 43, Arabian Coast, near Kuria Muria Islands ; 28.x.33. Hand-net ; surface.
2. Station 65, Gulf of Oman, 21.xi.33. " Came up on hydrographic wire above water-bottle."

* This area was deliberately omitted from the programme of the Expedition, as it was anticipated that the exploration of this region will be undertaken by the Government of Egypt in the near future.—Editor.

3. Station 95, Central area of Arabian Sea, 18.xii.33. 2-metre diam. tow-net, 984–430 metres (1400 metres of wire out).
4. Station 172, Central area of Arabian Sea, east of Cape Guardafui, 29.iv.34. 1-metre diam. tow-net, 200–0 metres (510 metres wire out).

Distribution.—*Tamoya alata* has been recorded by Rao (1931) from the Bay of Bengal (" a fairly large series of specimens "), and by Menon (1930) from the waters off Madras. The species is common in the Malay Archipelago (*vide* my " Discovery " Report, 1934, p. 342). It has not, hitherto, been recorded from the western part of the Indian Ocean, but most probably the so-called " *Charybdea* sp." mentioned by Browne (1905 and 1916) are identical with it.

The John Murray Expedition captured two specimens in the central part of the Arabian Sea, one off the south coast of Arabia and a fourth in the Gulf of Oman :

1. A very large specimen, well preserved, without, however, stomach and manubrium. The surface of the ex-umbrella is covered all over with large round nematocyst-clusters, which are highest and most numerous at the apex. Velarium with 13–15 velar canals, not anastomosing. Gonads complexly folded. Colour whitish-yellow. (Measurements given in the following table.)
2. Specimen fallen to pieces ; must have been somewhat larger than the first. Without gonads. Colour whitish, transparent. Pedalia 60 mm. long by 40 mm. broad.
3. Specimen not so well preserved as the first ; 12–13 velar canals, not anastomosing. Gonads feebly developed. Colour yellowish.
4. Specimen fairly well preserved, with very large nematocyst-clusters in the apical region. Gonads feebly developed. Gastric cirri distinctly visible. Colour pinkish.

Table of Measurements.

(All measurements are in millimetres.)

Specimen.	1.	3.	4.
Height of the bell	240	175	75
Breadth at the apex	85	65	25
,, in the middle	110	80	40
Length of pedalia	55	52	22
Breadth of pedalia	30	27	8
Distance of sensory-niche above margin	40	28	12
Average diameter of tentacles (most torn away)	3	5	5
Longest tentacle	1000 ?	80	22
Breadth of velarium	35	26	7

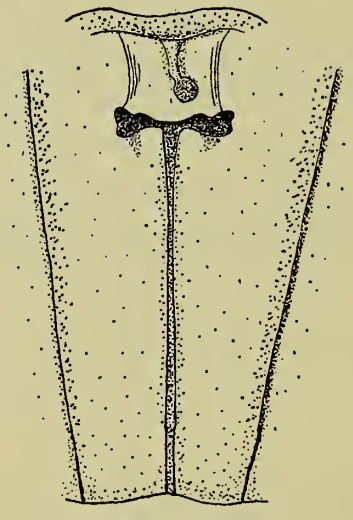
In spite of differences in the sculpture of the ex-umbrella all these specimens belong, I believe, to one very variable species, because they all agree in the form of the dumb-bell-shaped opening of the sensory-pit (the importance of this character has been explained by me in a previous paper (1919, p. 51). The first specimen, from Station 95, is remarkably large : Uchida (1929, p. 173) gives the maximum size of Japanese specimens as 220 mm.

The gonads in this specimen are " complexly folded " indeed, but are extremely brittle, and fall to pieces at the slightest touch with a pencil.

I give some figures and details of structure, taken from the large, best preserved specimen, since this extremely brittle medusa is but rarely obtained in a good state of preservation.

Velarium (Text-fig. 1).—The velar canals are very long and broad ; they are finely lobed and do not anastomose. Their shape is quite different from that figured by Uchida

Text-fig 1.



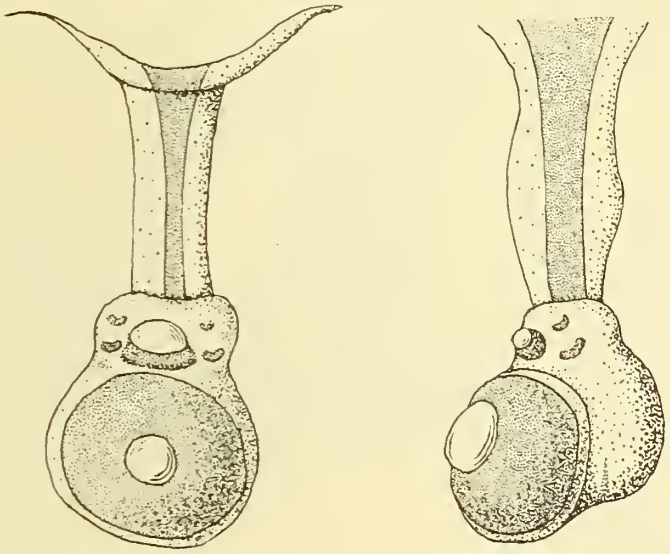
Text-fig. 2.

(1929, fig. 85) from a very young specimen, where they are mostly short and narrow, and agree with the figure given by me (1921, fig. 9). As the number and shape of the velar canals are, however, according to Uchida, subject to great changes during development, I do not believe that these characters merit so high a taxonomic value as has been attributed to them hitherto.

Sensory pits (Text-fig. 2).—The 4 sensory organs are lodged in a groove on a broad thickening of the jelly. The pits are of a very characteristic shape. In Uchida's figures (1929, figs. 81*a* and *b*) they are only faintly indicated. The opening of the pit is dumb-bell shaped, constricted in the middle, with two larger openings at the sides. The border

of the upper lip of the squama rhopalaris is wavy. The niche itself lies at a distance of about 40 mm. from the margin of the umbrella, and is separated from the neighbouring deeper and flatter parts of the ex-umbrella by deep and long furrows; these at their commencement run straight, but later, as they pass upwards, diverge and vanish slowly in the jelly of the umbrella. Beneath the sensory pit a small straight gully runs from the base of the niche to the border of the velarium.

The sensory organs (Text-fig. 3*a*, *b*).—These are very large. The median eye is globular with a large lens in the centre and is pigmented a very dark bluish-brown. The second eye lies above the first and is much smaller, but also has a small lens and a brown pigment mantle. Both pairs of crescent-shaped pigment-spots on the sides are brownish in colour.



a *b*

Text-fig. 3.

The concretion in the terminal knob is very large, strongly vaulted forwards and backwards, and also bears a faint crescent-shaped pigment-spot (Text-fig. 3*b*).

Tamoya alata being a typical surface medusa, the depths of the hauls, 984–430 metres and 200–0 metres, are remarkable. In the case of the latter haul at Station 172 and the specimen that was caught on the hydrographic wire at Station 65, these may have come from quite near the surface; but the same cannot be said of the specimen from Station 95, as at this station the self-closing mechanism was used, so that the net was not fishing on the way to the surface.

Family Chirodropidæ Haeckel, 1879.

Genus *Chiropsalmus* L., Agassiz, 1862.

Chiropsalmus quadrigatus Haeckel. (Text-figs. 4–9.)

References:

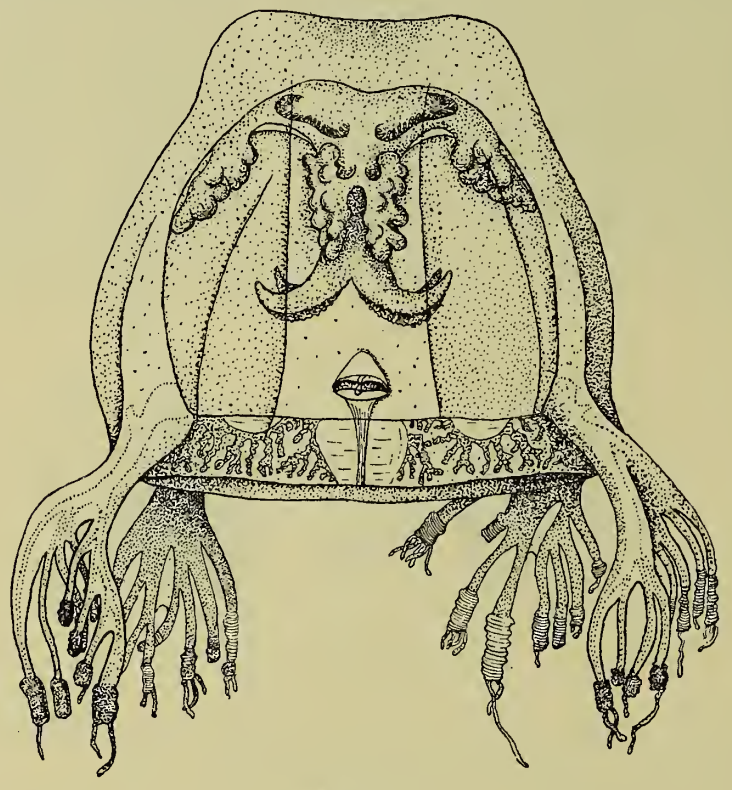
E. Haeckel, 1879, p. 447.
A. G. Mayer, 1910, p. 516, fig. 331A–E; 1917, pp. 190–191, fig. 4A–E.
G. Stiasny, 1922*b*, p. 517.

Occurrence :

Station 146, Lagoon of Horsburgh Atoll, Maldive Archipelago, 2.iv.34. Otter trawl, 37 metres.

1 specimen, together with 1 specimen of the fish *Leiognathus* (= *Equula*) *equulus* (Forsk), determined by Dr. F. P. Koumans.

Distribution.—This medusa has not hitherto been recorded from the western part of the Indian Ocean. It is not rare in Philippine waters (Mayer, Light). Haeckel records one specimen from Rangoon (*vide* my paper, 1922*a*, p. 517) ; another is mentioned by me from the Malayan Archipelago (*ibid.*).



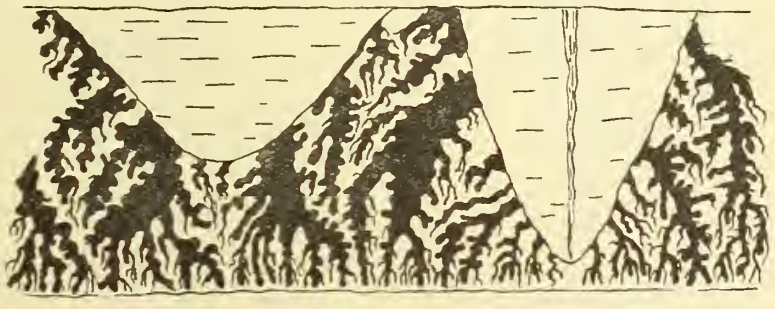
Text-fig. 4.

Descriptive Notes.—This medusa is poorly known. There exists only a short diagnosis and description by Haeckel (1879, p. 447) without figures, and a somewhat more detailed account by Mayer (1910, p. 516, and 1917, p. 190), both these papers having identical figures (side-view and details). Between these two descriptions there are certain discrepancies, to which Thiel (1927, p. 13) has already called attention, and he doubts whether the two accounts refer to the same species. I, however, believe that they do. I had the opportunity of examining the type-specimen of Haeckel's medusa in the collection of the Zoological Museum, Copenhagen (*vide* my paper, 1922*a*, p. 517), but was unable to add anything to Haeckel's description as the specimen is badly damaged and all the inner parts have vanished. The medusa is so fragile that it is very rarely captured undamaged and, moreover, falls to pieces at the slightest touch. The present specimen is not intact. The most important character of the species, namely the strangely formed gastric saccules, are, however, so distinctly described and figured by Mayer and are so clearly visible in

the present specimen that it was possible to identify both. I believe that the specimen is identical with *quadrigatus*, although there are some differences.

The umbrella with the pedalia is well preserved, but several of the inner parts, the manubrium with the stomach, the gastric saccules, etc., are partly detached and are hanging down, while most of the tentacles have been torn away ; but all organs are present and in a good state of preservation. I have, therefore, taken the opportunity of augmenting, as far as possible, the poor descriptions of previous authors, and have given a rather schematic sketch of the animal (Text-fig. 4, side view) ; it must, however, be recognized that this is nothing more than a reconstruction of the entire medusa and a recombination of the separated internal organs.

Height 70 mm., breadth 80 mm. at the level of the velarium ; rather a small specimen, Light having recorded some of 200 mm. size. The *bell* is nearly cube-shaped, with rounded edges, evenly rounded at the apex and a little narrower there than in the middle. Surface of the bell perfectly smooth, the jelly thick and cartilaginous. Side-pillars very strong,



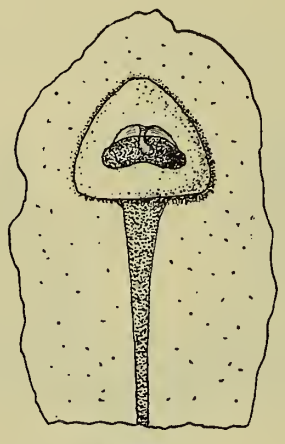
Text-fig. 5.

vaulted, pyramidal in shape with rounded ridges, bounded on both sides by deep furrows, merging gradually into the pedalia. Lateral sides of the bell rectangular, vaulted, separated from the side-pillars by a broad, plain, wedge-shaped zone. The *velarium* appears to have hung vertically instead of forming a horizontally-stretched diaphragm, supported by 4 bracket-like frenulæ, ± 18 mm. broad ; and there are 12 to 18 larger or smaller, finely ramified but not anastomosing velar canals in each quadrant (Text-figs. 4, 5).

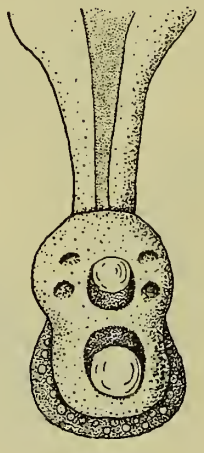
The 4 *niches of the sensory organs* (Text-fig. 6) lie upon a strongly protruding pyramid-shaped thickening of the jelly, about 22 mm. above the velar margin. The niche itself is a broad slit, somewhat narrowed by the projecting under-lip, but with only one opening that is not dumb-bell-shaped as figured by Mayer (1910, fig. 331, middle). Each *sense-club* (Text-fig. 7) bears, besides a large entodermal ball-shaped, terminal abaxial concretion on its inner side, 2 median eyes (one large, the other smaller), each with a prominent convex lens and a pigment mantle, and on each side two smaller crescent-shaped pigment-spots of brownish-yellow colour. The *pedalia* (Text-figs. 4 and 8) arise inter-radially in the middle of the height of the bell. They are ± 45 mm. long, scythe-shaped, somewhat twisted, and continued as a thinner pedicle, bearing two wings in the distal part ; the pedicle measures 18 mm. in length, the wings, when outstretched, ± 45 mm. broad. The wings are separated from each other by a deep notch, and each wing bears 4 symmetrically arranged, stiff finger-shaped tentacles, the uppermost being the longest (± 22 mm.) and the lowest the shortest. The pedalia are laterally compressed, quite transparent, with an

internal broad whitish vessel that bears a small horn-like, upwardly-directed projection on its outer side above the velarium. To each tentacle there runs a narrower whitish canal.

The *tentacles* are in their proximal parts laterally compressed, with sharp edges, transparent; distally they are somewhat thickened, cylindrical, opaque and covered all over the surface with numerous nematocyst-bearing rings. The distal end of the tentacles is rather puzzling and each tentacle is different; it may be plainly truncated without any appendix, or be provided with 1, 2, 3 or 5 shorter or longer, thicker or thinner, thread-like filaments. I have never before seen a similar appearance, but I do not believe that I am dealing here with an artefact.* Mayer's description is, however, somewhat con fusing; he speaks of " about 5 to 9 finger-shaped terminal projections, which give rise to an equal number of long flexible hollow tentacles ". In his figure the latter, however,



TEXT-FIG. 6.



TEXT-FIG. 7.

are not to be seen; here every projection bears only a single long, strong tentacle, the end of which is simple and thread-like. Mayer, I believe, must have seen something similar to what I have found.

The *mesenteries* are transparent, narrow, scythe-shaped membranes.

The *stomach* (Text-fig. 4) is flat and wide. The manubrium is 35 mm. in length, prismatic, with 4 sharp perradial edges and 4 strongly developed, simple, slightly folded lips, feebly bent upwards.

The whitish *gastric cirri*, very numerous, fusiform, simple, unbranched, ± 5 mm. long, are arranged in several inter-radial arched rows of ± 35 mm. length, lying along the upper border of the stomach.

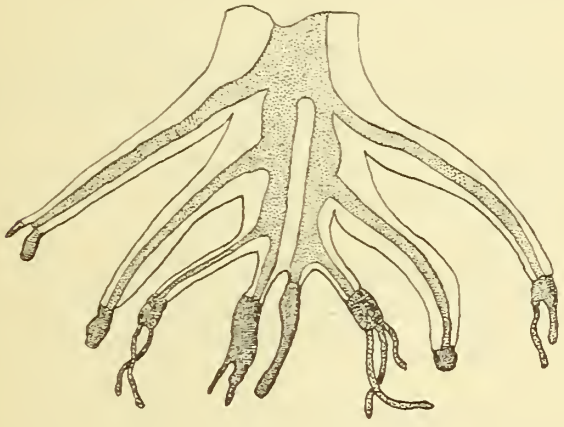
The 8 *gastric saccules* (Text-figs. 4 and 9), the most obvious and interesting character of this species, are wrongly figured in Mayer's side-view (1910 and 1917, figs. 331 and 4), but correctly in the oral view (figs. 331*c* and 4*c*, both identical). They are described by him as follows: " 4 pairs of gastric saccules arise from the per-radial sides of the stomach and project downward into the bell cavity. Each saccule is laterally flattened, cock's-combshaped, with an irregularly notched margin, and is about 20 mm. long and 11 mm.

* Perhaps the young " *Charybdea* spec." from Manokwari, New Guinea, with two rows of small tentacles on the larger ones may be a developmental stage of our medusa. The pedalia, however, of it have quite another shape. *Vide* my " Scyphomedusen ". Res. scient. du voy. du prince et de la princesse Léopold de Belgique dans les Indes Néerlandaises. Mem. Mus. Royal d'hist. nat., Bruxelles. Hors sér. vol. ii, 1930.

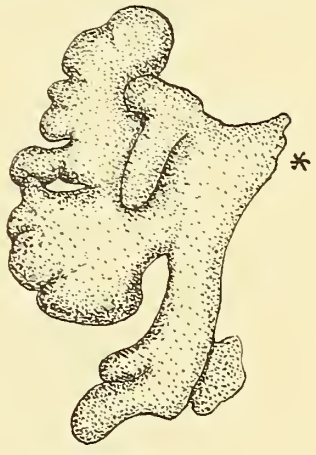
wide. A solid gelatinous projection extends downward so as to fill the greater part of the cavity of each gastric saccule." Light (1914, p. 197) gives a very brief but similar description—" each saccule is laterally flattened and cockscomb-shaped with an irregularly notched margin ".

Haeckel (1879, p. 44) described the saccules as small, egg-shaped and simple. The somewhat theoretical discussion of the gastric saccules by Thiel (1927, pp. 13–14) is hardly worth mentioning here, for he had no material in his own hands, and because he apparently has overlooked the description and the detailed figures of Mayer that show the strangely formed gastric saccules very distinctly, and furthermore, because he only speaks of the " eiförmige Gebilde " that is figured, rather erroneously, by Mayer in the middle of his large side-view of the entire animal.

In the present specimen the 8 saccules are about 35 mm. long and 15 to 20 mm. broad, and are situated on a short pedicle on the surface of the sub-umbrella on the per-radial



Text-fig. 8.



Text-fig. 9.

sides of the stomach. They are laterally flattened, irregularly lobed, hernia-like pouches, hanging freely in the bell cavity; and in front view are more like the superficial hemispherical or finger-shaped outgrowths of malachite or limonite than a cock's comb in shape (Text-fig. 4). Their surface is formed by a thin whitish plain membrane that is almost entirely filled with a thick translucent cartilaginous jelly of the same form, but a little smaller. According to Mayer (1917, p. 191), they may occasionally be absent altogether.

The *gonads* are poorly developed, nearly transparent leaves, mostly, however, torn to pieces.

Colour.—The jelly is translucent, like crystal, with a very soft bluish hue; all the inner organs are whitish-yellow and the rhopalia only show a brownish-yellow pigment.

The present specimen differs from the description by Mayer in various respects: in the velarium hanging down and not being stretched out like a diaphragm across the opening of the bell; in the form of the sensory niches (?); in the number of tentacles and perhaps also in the number of the small appendages at the end of the tentacles; and in the colour, there being no trace of a dull purple-pink coloration in the tentacles. I, however, believe both forms to be identical. It is, of course, not impossible that we may have here to do with quite another genus not known hitherto.

Order CORONATÆ Vanhoeffen, 1892.

Family PERIPHYLLIDÆ Haeckel, 1879.

Genus *Periphylla* Steenstrup, 1837.

Periphylla hyacinthina Steenstrup.

References :

Periphylla hyacinthina Steenstr., forma *dodecabostrycha*, forma *regina*, A. G. Mayer, 1910, pp. 544–547.
Periphylla hyacinthina Steenstr., G. Stiasny, 1934, pp. 343–365.

OCCURRENCE :

Station 18, Gulf of Aden near Berbera, 21.ix.33. 2-metre diam. tow-net, 900–0 metres (1500 metres of wire out).

3 specimens, forma *regina*, 80–100 mm. broad, well preserved, very deeply pigmented ; gonads feebly developed.

2 specimens, forma *hyacinthina*, without " Stielcanal ", 25 to 55 mm. broad.

Station 25, Gulf of Aden, near Cape Guardafui, 10.x.33. Agassiz trawl, 620 metres. (Some of the preserving fluid had leaked out, but about half was still left in the bottle.)

2 specimens, forma *dodecabostrycha*, 12 and 20 mm. broad, deformed, faded.

8 specimens, forma *regina*, 30 to 65 mm. broad, all flat, badly damaged, without stomach ; most specimens deeply pigmented, some with nearly the whole subumbrella covered with dark purple pigment ; gonads in all feebly developed.

Station 34, near Aden, 16.x.33. Agassiz net, 1022 metres.

12 specimens, forma *regina*, 35 to 82 mm. broad. Badly preserved and badly damaged ; pigment almost completely faded, 3 only with dark pigment ; gonads feebly developed.

Station 35, near Aden, 16.x.33. Otter trawl, 457–549 metres.

85 specimens, forma *regina*, 55–140 mm. broad. Flat, badly preserved, without stomach, most without gonads ; pigment markedly faded, some specimens nearly transparent, only the festoon on lappets and stripe in the middle of the same a dark purple ; larger specimens with ova. (In a brown fluid.)

1 specimen, forma *hyacinthina*, 45 mm. broad, with Stielcanal ; pigmented a dark purple.

Station 71, at the head of the Gulf of Oman, 26.xi.33. Otter trawl, 106 metres.

1 specimen, forma *regina*, 110 mm. broad ; better preserved ; with deep purple pigment on stomach, sub-umbrella and lappets ; gonads feebly developed.

Station 96, central part of the Arabian Sea, 19.xii.33. 2-metre diam. tow-net, 400–645 metres (900 metres of wire out).

1 specimen, forma *dodecabostrycha*, transitional stage to *hyacinthina*, 55 mm. broad. Well preserved, but somewhat damaged ; with rounded top and with " Stielcanal " ; stomach dark purple ; eggs visible from without.

Station 108, to the west of Pemba island, near Zanzibar, 13.1.34. Agassiz trawl, 786 metres.

1 specimen, forma *dodecabostrycha*, 32 mm. broad. Deformed, with "Stielcanal"; colour faded.

Station 121, Zanzibar area, 21.i.34. Agassiz trawl, in 925 metres depth, but net apparently not on the bottom.

2 fragments of the border of one or two large specimens, forma *regina*, 50 and 110 mm. broad. With pedalia, lappets and tentacles. Dark brown stripe in the middle of each lappet very broad; numerous large ova.

1 specimen, forma *dodecabostrycha*, 22 mm. broad. Very well preserved, with "Stielcanal"; very deeply pigmented; no gonads.

Station 176, Gulf of Aden, near Cape Guardafui, 2.v.34. Agassiz net, 655–732 metres.

37 specimens, forma *regina*, 34–100 mm. broad. Badly preserved, most without stomach; pigment faded, only a purple stripe on the lappets; gonads feebly developed or absent.

7 specimens, forma *regina*, 50–90 mm. broad. Better preserved than the others, mostly damaged; with more dark brown pigment on the muscles of the lappets and stomach; gonads visible on the two largest specimens only.

Station 185, Gulf of Aden, 5.v.34. Agassiz net, 2000 metres.

2 specimens, forma *regina*, ± 115 mm. broad. Flat, badly damaged; pigment faded with the exception of a dark purple radial stripe on the sub-umbrella side of each lappet; without gonads.

Station 186, Gulf of Aden, 5.v.34. 2-metre diam. tow-net, 952–0 metres (1500 metres of wire out).

50 specimens, forma *regina*, ± 85 mm. broad. Damaged; colour faded, festoon a yellow band; gonads well developed.

Station 193, near Aden, 7.v.34. Agassiz trawl, 1061 to 1080 metres (a repeat of Station 34).

55 specimens, forma *regina*, 25 to 130 mm. broad. Mostly damaged; almost without pigment; gonads developed in the largest specimens. Preserving fluid a deep brown colour.

The total number of specimens obtained was 237. The majority are flat, low domed, and of the *regina* type; 15 very small examples were of the *dodecabostrycha* type, and 3 only of the *hyacinthina* type (for these terms see my "Discovery" Report, 1934, p. 353). Most specimens are in a poor state of preservation in formalin, are badly damaged with the stomach, tentacles and lappets torn away and are deformed; many specimens bore traces of the bottom mud. The pigment has faded in nearly all and some are wholly transparent; in others the dark purple stripe on the underside of the lappets is the only poor remains of the original pigmentation. The specimens from Station 18 alone show fresh colours; in some of the jars the pigment had come out and the medusæ were found in a dark brown fluid. It may be that the Agassiz trawl is not very suitable for these catches, and that the specimens had been exposed for a time to direct sunlight before undergoing preservation. It is obvious that the flat *regina* type without "Stielcanal" can be recognized here even in small specimens of about 25 mm. breadth, although in my "Discovery" Report (1934) I have indicated 80 mm. as the minimum size for the forma *regina*.

There are very few specimens of the *hyacinthina* type, and the few of the *dodecabostrycha* type are from lesser depths. Most remarkable are the catches from the four Stations 35, 176, 186 and 193, which include by far the majority of the specimens.

On sorting out the plankton samples there was found from—

Station 172, Central part of the Arabian Sea, 29.iv.34. 2-metre diam. tow-net, 2091–0 metres (2665 metres of wire out):

1 specimen of *Periphylla hyacinthina* in the " Bigelow "-stage (*vide* my " Discovery " Report, 1934, p. 343); 12 mm. broad; no apical projection of the stomach into the mesoglœa; peripheral system entirely hyaline; stomach alone with dark brown pigment; somewhat deformed.

Distribution.—This medusa has previously been recorded from the Gulf of Aden, north and south-east of Cape Guardafui, north of Socotra, from various localities along the Somali coast and between the Seychelles and Zanzibar; but no specimen is known from the eastern part of the Arabian Sea, and only once has it been taken in the region between the Laccadives and India. The John Murray Expedition collected many specimens in the Gulf of Aden, near Cape Guardafui and south-east of it, some in the centre of the Arabian Sea and near Zanzibar; but not a single example in the eastern part of the Arabian Sea and only one in the Gulf of Oman. In the Red Sea *Periphylla hyacinthina* has never been caught. Where can the specimens in the Gulf of Aden have come from ? For a discussion on this point see p. 238.

In the eastern part of the Indian Ocean this species has been recorded by Rao (a single specimen) from the Bay of Bengal. The medusa is, however, not rare in the Pacific Ocean in Philippine waters and in the Malay Archipelago, and it seems unlikely that it is in fact so rare in the Indian Ocean. If we consider the season during which the catches have been made, we see that the medusæ from Station 176, 44 specimens, Station 186, 59 specimens, and Station 193, 55 specimens, were collected in the Gulf of Aden in the month of May; the catches at Station 25, 10 specimens, Station 34, 12 specimens, and Station 35, 86 specimens, were made in October. In September and December only a few specimens were captured. By far the greater number of examples have thus been taken in May and October at the time of the change of the monsoons, and it seems possible that the seasonal changes may have a great influence on the appearance of these deep-sea medusæ.

Family Nausithoidæ Claus, 1878.

Genus *Nausithoë* Kölliker, 1853.

Nausithoë punctata Kölliker.

References:

A. G. Mayer, 1910, pp. 554–556, figs. 352–354.
For other references see below.

Occurrence:

Station 145c, east end of Kardiva channel, Maldive area, 1.iv.34. 1-metre diam. tow-net, 100–0 metres vertical haul.

1 specimen, 7 mm. broad. Deformed; gonads well developed with large ova; colour yellowish.

Distribution.—This cosmopolitan medusa, the range of which includes the tropical belts of all three large oceans, has been recorded previously by Bigelow (1901–4, p. 263) from the Maldives, by Browne (1905*a*, p. 154) from the waters off Ceylon, and later (1916*a*, p. 202) from the Chagos Archipelago and the Amirante Islands. Vanhoeffen (1903, pp. 29–30), in his "Valdivia" Report, mentions it from several localities along the East African coast and in the Gulf of Aden. In the plankton catches of the John Murray Expedition only a single specimen of this, usually so common, medusa was taken in Maldive waters.

The distribution of *Nausithoë punctata* seems to be restricted to the peripheral parts of the Arabian Sea, with the exception of the northern parts, whence it has not yet been recorded. It is, however, rather doubtful whether this medusa is in fact so rare in the Arabian Sea.

Family Atollidæ Bigelow, 1913.

(Synonym : Collaspidæ Haeckel, 1879.)

Genus *Atolla* Haeckel, 1879.

Atolla wyvillei Haeckel.

References :

A. G. Mayer, 1910, p. 566.
H. B. Bigelow, 1928, pp. 505–509.
G. Stiasny, 1934, pp. 366–379, pl. xv, fig. 4, text-figs. 3–6.

Occurrence :

Station 18, Gulf of Aden, near Berbera, 21.ix.33. 2-metre diam. tow-net, 900–0 metres (1500 metres of wire out).

6 specimens, *bairdii*-type,* 42–50 mm. broad. Deformed, strongly pigmented, all with well-developed gonads.

Station 25, Gulf of Aden, near Cape Guardafui, 10.x.33. Agassiz trawl, 620 metres.

1 specimen, *bairdii*-type, 55 mm. broad. Deformed ; pigment faded ; with gonads. (With many *Periphylla hyacinthina*.)

Station 34, Gulf of Aden, 16.x.33. Agassiz trawl, 1022 metres.

1 specimen, *bairdii*-type, 35 mm. broad. Gonads feebly developed ; colour faded, yellowish-green. (With many *Periphylla hyacinthina*.)

Station 35, Gulf of Aden, near Aden, 16.x.33. Otter trawl, 457–549 metres.

3 specimens, *verrilli*-type, ± 65 mm. broad ; with sharply indented border of central disk.

* *Vide* Bigelow (1928) and my "Discovery" Report (1934, p. 361). Three types of this species can be recognized, namely : (1) *bairdii*-type with a smooth central disc ; (2) *verrilli*-type with central lens scored with narrow furrows ; (3) *wyvillei*-type, central lens indented with broad deep radial furrows,

6 specimens, *bairdii*-type, 32–45 mm. broad; deformed; all nearly without pigment; gonads mostly well developed.

Station 98, central part of the Arabian Sea, 22.xii.33. 2-metre diam. tow-net, 2800–0 metres (vertical).

1 specimen, *bairdii*-type, 75 mm. broad. Very well preserved, but pigment faded; colour yellowish green; gonads nearly mature.

Station 121, near Zanzibar, 21.i.34. Agassiz net, in depth of 925 metres, but net probably not on bottom.

4 specimens, *bairdii*-type, 15–25 mm. broad. Colour faded; without gonads.

Station 172, Arabian Sea, east of Cape Guardafui, 29.iv.34. 2-metre diam. tow-net, 2091–0 metres (2665 metres of wire out).

4 specimens, *bairdii*-type, 12, 18, 28 and 62 mm. broad. All pigment faded and nearly transparent; oldest only with gonads.

Station 176, Gulf of Aden, 2.v.34. Agassiz net, 655–732 metres.

1 specimen, *bairdii*-type, 45 mm. broad. Transparent, colour greenish-yellow; gonads feebly developed. (With many *Periphylla hyacinthina*.)

Station 186, Gulf of Aden, 5.v.34. 2-metre diam. tow-net, 952–0 metres (1500 metres of wire out).

5 specimens, *bairdii*-type, 25–52 mm. broad. The three largest highly vaulted, 35 mm. high, with gonads; others flat, unripe. All faded, nearly without pigment. In one smaller specimen of 40 mm. breadth, the exumbrella is covered with a network of the central disk.

Station 193, Gulf of Aden, 7.v.34. Agassiz trawl, 1061–1080 metres.

1 specimen, *bairdii*-type, 22 mm. broad. Faded; without gonads. (With many *Periphylla hyacinthina*.)

In all 34 specimens were captured, most of which were of the *bairdii*-type, only 3 of the *verrilli*-type and none of the *wyvillei*-type. No example was taken of *A. chuni*, with glass-like beads on the lappets. All the specimens were faded; most were without pigment and nearly transparent or, on the whole, yellowish-green in colour with the ring-muscle an intense yellow-green. The gonads were but little developed.

Distribution.—Previous records of *Atolla wyvillei* are from the Gulf of Aden, to the south of Cape Guardafui, the Somali coast, between the Seychelles and Zanzibar, to the north-east of the Seychelles, the Chagos Archipelago, the Maldives and off Colombo; in every case a few specimens only. The John Murray collection comprises many specimens from the Gulf of Aden and near Cape Guardafui, and a few from Zanzibar and the central part of the Arabian Sea; no examples are from the northern part of the Arabian Sea or from the coastal waters of British India. *Atolla wyvillei*, therefore, seems to be restricted to the southern part of the western half of the Indian Ocean, with preference for the peripheral waters. Rao (1931) mentions a few specimens from the Bay of Bengal, the Laccadives and the Andaman Sea. There are no records of *Atolla wyvillei* from the Red Sea. It is strange that this medusa, that is known from the depths of all the oceans, should be relatively rare in the Indian Ocean.

Order SEMÆOSTOMEÆ L., Agassiz, 1862.

Family Pelagidae Gegenbaur, 1856.

Genus *Pelagia* Péron and Lesueur, 1809.

Pelagia noctiluca (Forskål).

References :

A. G. Mayer, 1910, pp. 572, 573.
H. B. Bigelow, 1928, pp. 517–520.
G. Stiasny, 1934, pp. 386–388.
G. Stiasny, 1935, pp. 14–16.

Occurrence :

Station 61, Northern part of Arabian Sea, off Karachi, 8.xi.33. 2-metre diam. tow-net, 2000–0 metres (2265 metres of wire out).

6 specimens, *panopyra*-type, 17–19 mm. broad. All yellowish-brown in colour, not translucent ; gonads developed in the largest specimen only. (Together with 4 *Halicreas*.)

Station 67, Gulf of Oman, near Muscat, 22.xi.33. Hand-net, surface.

13 specimens, *panopyra*-type, 17–42 mm. broad. Partly damaged ; whitish-yellow in colour ; gonads feebly developed. In some specimens very long tentacles, three times the diameter.

Station 73, Gulf of Oman, 27.xi.33. Hand-net, surface.

8 specimens, *panopyra*-type, 15–26 mm. broad. Well preserved ; whitish-yellow in colour ; gonads only in the largest specimen, pinkish in colour.

Station 87, West of Bombay, 7.xii.33. Agassiz trawl, 549–640 metres.

69 specimens, 15–35 mm. broad ; most of the *noctiluca*-type, some of the *panopyra*-type and a few only of the *cyanella*-type. Specimens deformed ; yellowish-white in colour ; gonads in all well developed, pink in colour.

Station 99, south-west of centre of Arabian Sea, 23.xii.33. Hand-net, surface.

1 specimen, *panopyra*-type, 25 mm. broad. Whitish-yellow in colour ; gonads well developed, pink coloured. (Together with 2 large *Æquorea*.)

Station 101, east coast of Africa, north-east of Mombasa, 27.xii.33. Hand-net, surface.

17 specimens, *panopyra*-type, 7–28 mm. broad. Well preserved ; yellowish-white in colour ; gonads feebly developed.

9 Ephyrae, 4 mm. broad, with short tentacles and one or two long gastric cirri only in each quadrant.

Station ?, Zanzibar area.

1 specimen, *panopyra*-type, 32 mm. broad. Yellowish-white in colour, opaque ; gonads well developed, yellowish-brown ; tentacles short and thick.

There are in all 115 specimens ; most of them are of the *noctiluca*-type, with the whole surface of the umbrella covered with elongated warts ; several are of the *panopyra*-type with rounded warts, and a few only of the *cyanella*-type with a smooth marginal zone (see Bigelow, 1928).

Most specimens were caught with the hand-net at the surface. The two catches, from Station 61 with the 2-metre diam. tow-net from 2000–0 metres and from Station 69 with the Agassiz net at 549–640 metres, when 69 specimens were obtained, are remarkable. It may be that in each case the medusæ were caught during the last moment of the haul ; but it is, however, not impossible that both catches were from major depths. Similar hauls were effected by the " Snellius " Expedition in the Malayan Archipelago (Stiasny, 1935, p. 15). It is, therefore, not improbable that *Pelagia noctiluca*, a typical surface medusa in moderate latitudes, descends in tropical waters to major depths.

In the plankton samples the following developmental stages were found :

Station 96, central part of the Arabian Sea, 19.xii.33. 1-metre diam. tow-net, 10–0 metres (14 metres of wire out).

8 post-ephyral stages, 3–5 mm. broad. Deformed ; brownish-yellow in colour. Together with some hydromedusæ.

Station 76, Gulf of Oman, 29.xi.33. 1-metre diam. tow-net, 200–0 metres (300 metres of wire out).

2 post-ephyral stages, 8 mm. broad. Badly preserved ; colour whitish, transparent.

Distribution.—*Pelagia noctiluca* has hitherto been recorded from the Somali coast, Zanzibar, east of Zanzibar, west of the Seychelles, the Chagos Archipelago, the Maldives and the Gulf of Manaar, as well as from the South Indian Ocean. It is rather astonishing that this very common medusa has not previously been taken in the northern part of the Arabian Sea or in the Gulf of Aden. The John Murray Expedition collected it in the central part of the Arabian Sea, near Zanzibar, in the northern part of the Arabian Sea and in the Gulf of Oman ; so this gap is now filled. Rao (1931) mentions one specimen from an unknown locality in the Indian Seas, and Menon also records the species—the actual number of specimens is not indicated—from the waters off Madras. It is a very common form in the Philippine Archipelago and in Malayan Waters (*vide* Mayer [*P. panopyra* Pér. & Les., 1917, p. 199] and the author [1935, pp. 14–16]).

Pelagia noctiluca may be regarded as being distributed all over the Indian Ocean and the Arabian Sea. It is curious that the John Murray Expedition did not collect a single specimen in the eastern part of the Arabian Sea and in the Maldive and Laccadive waters, in a region where this medusa has in the past been recorded repeatedly.

Descriptive Notes by Lt.-Col. R. B. Seymour Sewell.—In the freshly-caught examples of this medusa the gonads are rose-pink in colour, and so are the four sub-umbrella tentacles ; the marginal tentacles are also coloured rose-pink in their proximal parts, but the colour fades to yellow at the extremities.

At Station 101 during the morning and at mid-day there was very little plankton to be seen at the surface ; but towards the late afternoon, from 3.30 p.m., the amount increased very considerably. At 9 a.m. a single example of *Pelagia noctiluca* was seen, but in the evening a number were caught and many more could be seen beyond the range of the hand-net. Associated with these medusæ were small black Amphipods ; it was rare to capture a medusa without taking one at least of these Amphipods, whereas one could

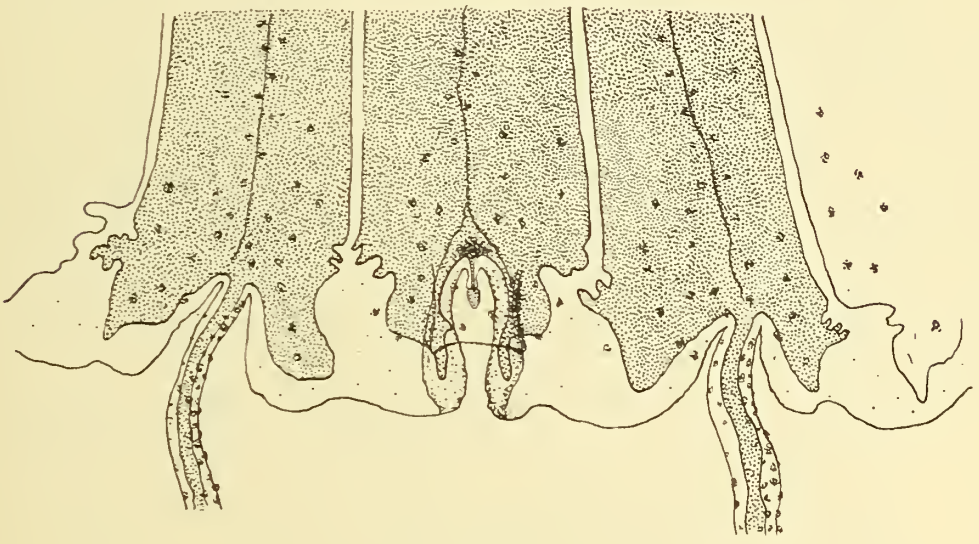
sweep the net through the water for several minutes without capturing one. So there seems to have been a definite association.

Genus *Sanderia* Goette, 1886.

Sanderia malayensis Goette. (Pl. I, figs. 1, 2 and 3; and Text-fig. 10).

References :

A. G. Mayer, 1910, p. 590.
E. Vanhoeffen, 1903, p. 38, taf. iii, fig. 12; taf. viii, figs. 69–74.
E. T. Browne, 1926, pp. 110–112.
G. Stiasny, 1935, pp. 18, 19.



Text-fig. 10.

Occurrence :

Station 25, Gulf of Aden, near Cape Guardafui, 10.x.33. Hand-net, surface; from a clump of Sargasso weed.

1 specimen, 63 mm. broad. Badly damaged; colour whitish-yellow; gonads brownish-yellow, not transparent, almost mature. Their papillæ lie very irregularly one upon another. The stomach pouches (Text-fig. 10) show on their sides in the neighbourhood of the border of the umbrella, both in the tentacular and rhopalar areas, strangely formed lobes or outgrowths, that alternate with deep sinuses. The tentacular pouches protrude distally farther into the lappets than do the rhopalar and they are larger and broader; the latter become very narrow and protrude, as small digitiform outgrowths only, into the rhopalar lappets. The lappets are still plain, but a later fission is indicated by an outward incision. Above the rhopalium there is a small flat smooth groove. Exactly in the middle of both pouches the entoderm shows a longitudinal fold; above the rhopalium this fold bifurcates and gives rise to an appearance as of a bifurcating vessel running to the rhopalium; but this is not the case; it is a fold only of the entoderm lamella. In the tentacular pouches a similar fold runs to the root of each tentacle but does not bifurcate there.

Station 61A, northern area of the Arabian Sea, off Karachi, 8.xi.33. 1-metre diam. tow-net, 1000–0 metres (1136 metres of wire out).

2 developmental stages, both in the *Pelagia*-stage, 10 and 15 mm. broad, 7 and 5 mm. high, with 8 marginal sense-organs, 8 tentacles, 16 cleft marginal lappets and 16 peripheral stomach pouches, very similar to those captured by the " Snellius " Expedition in the Malayan Archipelago (*vide* Stiasny, 1935, pp. 18, 19) (Pl. I, fig. 2). Both were very obviously flattened at the top, as if they had been cut off, with a conical elevation in the centre and large round transparent warts all around it. Manubrium very long, ± the radial length ; tentacles also ± the radial length. Genital ostia bordered externally by very few folds, the latter forming finger-shaped papillæ. Colour yellowish-white, stomach and tentacles opaque white.

Station 75, Gulf of Oman, 28.xi.33. Hand-net, surface.

27 younger and older ephyræ, 3–5 mm. broad (Pl. I, fig. 3).

These are the youngest stages of development that are so far known of this medusa. The smaller ones are flat, nearly transparent, finely granulated on the ex-umbrella ; tentacles = ± diameter) ; the gastro-vascular system is opaque white and is distinctly visible. The larger examples are mostly vasiform, manubrium long (± the radial length), still without gastric cirri ; the peripheral system yellowish-white, and the rhopalia without pigment. Most of the specimens are slightly damaged at the border. There are some abnormalities to be seen ; one specimen possessed 36 stomach pouches, 18 tentacles and 18 rhopalia ; a second specimen had 28 stomach pouches. In another example the septum between two adjacent stomach pouches is forked. Similar abnormalities have been observed by previous authors.

Station 76, Gulf of Oman, near Muscat, 29.xi.33. 2-metre diam. tow-net, 2500–0 metres (2800 metres of wire out).

5 specimens, 35, 38, 45, 47 and 55 mm. breadth ; flat. Colour greenish-yellow without any trace of pigment. Surface of ex-umbrella covered with small granules. At the apex the small papillæ are highest, the border of the ex-umbrella being nearly smooth. Lips of mouth 2 diameters in length. tentacles 3 diameters in length. The tubular œsophagus is, in most specimens, about the length of the radius, as was the case in the specimens collected by the " Snellius " Expedition in the Malayan Archipelago (*vide* Stiasny, 1935, pp. 18–19). The tentacles are somewhat thickened at the base and taper to long hair-like threads, which reach almost three times the diameter in length. They are much thinner than the ribbon-like broad tentacles of a specimen, not very much larger than the present, that was described by Vanhoeffen from the Gulf of Aden. They are a little compressed laterally. The gonads in the smaller specimens are visible only as small finger-like fringes, arranged in the form of an arch or crescent. In the older and better preserved specimens the finger-shaped papillæ have grown longer (Pl. I, fig. 1) ; they are far less regularly arranged, one next the other, than is figured by Vanhoeffen (*vide* his, in other respects, excellent figure, pl. viii, fig. 69), and do not form a heart round the

subgenital ostia, but a broad horse-shoe, the inner ends of which are widely separate and which fuse with the next in the narrow interspaces.

In my "Snellius" Report (1935, pp. 18–19) I have recently discussed this species with reference to some specimens from the Malayan Archipelago. The present examples agree with the Malayan in that in both cases pigment is completely absent, and no trace is to be seen of the fine yellowish-brown stripes on the ex-umbrella that were observed by Vanhoeffen in living specimens taken by the "Valdivia" Expedition (*vide* his pl. iii, fig. 12).

Distribution.—This medusa was caught many years ago by the "Valdivia" in the Gulf of Aden (Vanhoeffen, 1902, p. 37), and has more recently been recorded by Browne (1926) in the material of the Suez Canal Expedition, which contained 30 specimens. Other records of it from the Indo-Pacific area are from Singapore (Goette), the Malay Archipelago (Stiasny) and the Philippines (Mayer), in each case a few specimens only. The localities of the John Murray Expedition are Cape Guardafui, Gulf of Oman and off Karachi —relatively numerous localities for this rather rare medusa. Five specimens were caught with 2800 metres of wire out; they most probably did not, however, come from the deeper depths, as this medusa is known to be a typical surface form. The specimen from Station 25 was, apparently, attached to a clump of Sargasso weed; the tentacles are, in fact, exceedingly glutinous, and if they are touched with a pencil or needle one cannot easily get rid of them. It is striking that not a single specimen of this medusa was caught in the eastern half of the Arabian Sea, as was to be expected according to all previous records. On the contrary, two localities are situated in the Gulf of Oman and a third in the northern part of the Arabian Sea; no specimen was collected in the waters of the Maldive, Laccadive and Chagos Archipelagos.

Family Ulmaridæ Haeckel, 1879.

Sub-family Aurelinæ L., Agassiz.

Genus *Aurelia* Péron and Lesueur, 1809.

Aurelia maldivensis Bigelow.

References:

H. B. Bigelow, 1904, p. 261, pls. vi, viii, figs. 22, 23, 27.
G. Stiasny, 1935, pp. 32, 33, fig. 8.

Occurrence:

Station 41, South Arabian coast, Kuria Muria Islands, 27.x.33. Hand-net, surface.

2 specimens, (i) badly damaged, colour whitish-yellow; (ii) 130 mm. broad, colour pinkish.

Station 99, Central part of Arabian Sea, 23.xii.33. Hand-net, surface.

4 specimens, 120–140 mm. broad; mature, colour yellowish-white.

Station ?, Zanzibar Harbour, 25.i.34. Hand-net, surface.

2 specimens, 120–170 mm. broad. Badly preserved, colour yellowish-white, nearly mature.

Station 131d, southern area of Arabian Sea, east of the Seychelles, 11.ii.34. 1-metre diam. tow-net, 500–0 metres vertical haul.

1 specimen, 70 mm. broad. Very transparent, colour yellowish-pink, with many abnormalities in the gastro-vascular system. Gonads feebly developed.

All nine specimens show, as did those described by me in the report on the "Snellius" medusæ (1935, pp. 32–33), the mouth-arms strongly thickened in the proximal parts and irregularly twisted; the lips broad. The colour, however, does not agree; the present specimens are not lilac or reddish-brown, but yellowish-white or pinkish. In most specimens the gonads were mature.

Distribution.—The species, *A. maldivensis*, is recorded by Bigelow from the Maldives and by me from the Red Sea (Port of Perim), and recently from the south cape of the Sinai Peninsula. *Aurelia maldivensis* has been collected by the John Murray Expedition in the central part of the Arabian Sea near the Seychelles, in the waters off Zanzibar and near the Kuria Muria islands. It was not taken by the expedition in the eastern part of the Arabian Sea nor near the Maldive and Chagos Archipelagos—localities where previously most specimens of the form have been caught.

Notes by Lt.-Col. R. B. Seymour Sewell.—On October 8th, 1933, to the east of Ghubbet Minna, off the Somali coast, in a depth of 138 fathoms a number of examples of a species of *Aurelia* drifted past the ship; the species was thicker in the umbrella than *Aurelia aurita* and was possibly *A. maldivensis*. They were of a delicate mauve or purple-blue colour, with the gonads showing up in darker colour than the rest of the animal.

On October 31st, off Ras Madraka on the south-east coast of Arabia the surface plankton was very rich, and included a number of examples of *Aurelia* of apparently the same species as before. Further specimens were seen on the surface on December 23rd at Station 99, and nearly 50% of the medusæ were accompanied by a small fish.

On January 25th and 26th, 1934, while at anchor in Zanzibar Harbour the expedition again encountered this medusa; there were literally thousands present at the surface and, where they were drifted against the ship's side by the wind, there were hundreds that were actually touching each other, so close were they packed. Swimming backwards and forwards at a slightly greater depth than the medusæ were numerous small fish, and these could be seen to dart in under the umbrella of the medusa and then dart away again. In cases where the medusa had descended to a slightly lower level than that of the general shoal, several of these little fish could be seen around the same medusa, apparently busily engaged in feeding on the medusa itself. Quite a number of examples that were captured and examined had had their tentacles damaged, and in some cases these were actually non-existent, apparently eaten away by the small fish. In life these medusæ were of a delicate mauve or purple-blue colour, with the gonads showing up in a darker colour than the rest of the animal. When ripe the gonads are of a rose-pink colour that is not confined to these organs, but is also seen in the radial canals and still more markedly in the marginal tentacles.

By the 29th the number of *Aurelia* present had greatly diminished, though there were still large numbers to be seen drifting past the ship.

Mr. O. M. Latter informed me that while he was on the way out to Colombo in the Orient liner "Orford" a shoal of medusæ, of apparently the same species, was encountered off the Somali coast, both before and after passing Cape Guardafui, on February 5th and 6th, 1934.

Order RHIZOSTOMÆ Cuvier, 1799.

Sub-order KOLPOPHORÆ Stiasny, 1921.

Section ACTINOMYARIÆ Stiasny, 1921.

Family CEPHEIDÆ Stiasny, 1921.

Genus *Netrostoma* Schultze, 1898.

Netrostoma cœrulescens Maas.

References :

O. Maas, 1903, pp. 35–38, pl. v, figs. 37–46 ; pl. xi, figs. 97, 103 ; pl. xii, fig. 109.
E. T. Browne, 1905, pp. 967–970.
M. G. K. Menon, 1930, p. 13, pl. ii, fig. 7*a–d*.

OCCURRENCE :

Station 75, Gulf of Oman, Strait of Hormuz, 28.xi. 33. Otter trawl, 210 metres.

1 specimen, 90 mm. broad. Badly damaged on the border, mouth-arms torn away. Muscle-rays strong, gastro-vascular system visible here and there (type *Cephea*, sub-type *Netrostoma*, with 3 inter-rhopalar canals) ; colour bluish, transparent.

This is a surface form, caught here by the open otter trawl ; the depth, 210 metres, is remarkable.

DISTRIBUTION.—Very common in Malayan and Philippine waters, but seldom taken in the Indian Ocean. Browne reports the species from the Maldive waters and Menon from Madras. In the western parts of the Indian Ocean and the Arabian Sea this medusa has not previously been captured ; it is, therefore, not uninteresting that the John Murray Expedition obtained one specimen so far north in the Arabian Sea as the Straits of Hormuz.

Genus *Cephea* Péron and Lesueur.

Cephea sp. (Text-fig. 11.)

References :

A. G. Mayer, 1910, p. 651*a*, *f*.
E. Vanhoeffen, 1902, pp. 45, 46, and pl. iv, figs. 13 and 14, for *C. cœrulea* Vanh.
M. G. V. Menon, 1930, p. 12.

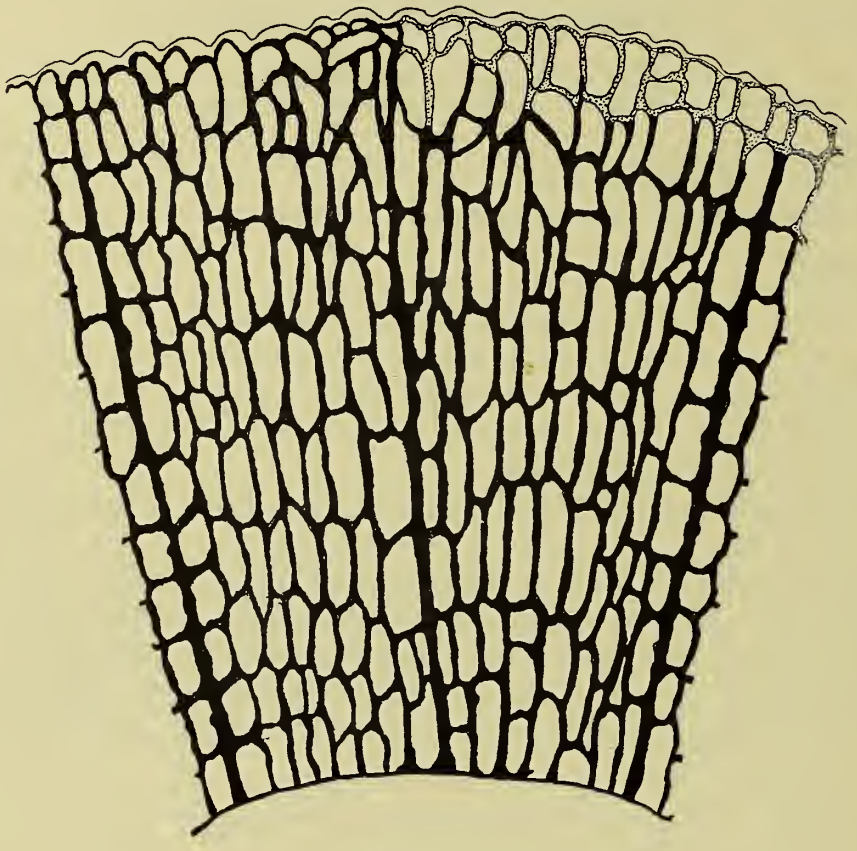
OCCURRENCE :

Station 61A, northern area of Arabian Sea, off Karachi, 8.xi.33. 2-metre diam. tow-net, 2000–0 metres (2265 metres of wire out).

1 specimen, 260 mm. broad, damaged ; with numerous fragments of another specimen.

REMARKS.—The large specimen is badly damaged ; there is only the umbrella with a gaping hole in the centre, a part of the border and the stomach ; the remainder, including the arms, has been torn away. The whole disc is thin and weak, and is of a yellowish-brown colour. The muscles are obviously feeble ; the meshes of the gastro-vascular system are, however, faintly visible. I could not detect a single sense-organ on the border

(Text-fig. 11). The lappets are small, rounded, similar in appearance and regular in form. In the canal system 16 slightly broader canals are indistinctly visible between the finer mesh-work. Nowhere could I find any incisions for the niches of the sense-organs. Not being able, however, to recognize the rhopalia, I was unable to distinguish the rhopalar from the inter-rhopalar canals. All vessels anastomose immediately after leaving the stomach. The number of canal-roots may be 6 or 8. Text-fig. 11 is of a rather schematic character and is to be regarded merely as a sketch, drawn to give an impression of the



Text-fig. 11.

canal system. It may be that we have to do here with a new type of canal system, all other known species of the genus *Cephea* having 8 principal radial canals only. I, however, cannot say anything with certainty regarding this point. Very obvious is the extremely feeble development of the muscles. In Actinomyariæ the muscle-rays are commonly very strongly developed ; but in the present specimen, on the contrary, hardly any trace of musculature can be seen.

The surface of the ex-umbrella is covered with irregular, polygonal, flat humps, separated by shallow furrows ; near the border the surface is smooth.

In the numerous fragments of the second specimen the jelly is somewhat stronger, more resistant and of a greyish-blue colour. There are only fragments of the umbrella without lappets or sense-organs. The muscles here, too, are poorly developed. The mesh-work of the anastomoses of the gastro-vascular system is of yellowish-brown colour, and shows a similar pattern to that of the first specimen.

The specimen was hauled with the 2-metre diam. tow-net from the remarkable depth of 2000 metres. The species of *Cephea* being, however, known to be typical surface medusæ. the specimen was. perhaps, caught in the last moment of the haul.

I dare not attempt to determine the species to which this specimen and the fragments may belong ; and I have even considered the possibility that I might be dealing with a species of the genus *Cassiopea*, that is well known from these waters. The type of the network, however, conforms with certainty to the *Cephea*-type, but the feeble development of the muscles does not agree with the strong muscle-rays so typical, otherwise, of the Actinomyariæ. It is possible that this is a specimen of *Cephea cœrulea* Vanhoeffen, that was taken by the " Valdivia " Expedition near Dar es Salaam ; this latter species possesses 8 rhopalia and 7 inter-rhopalar canals. but, according to the description of Vanhoeffen (1903, p. 46), has very strong radial muscles. It is most unfortunate that both specimens are in such a bad state of preservation that a more accurate study and determination is impossible.

Distribution.—This genus has only twice been recorded in the literature from the Indian Ocean, namely, *Cephea cœrulea* by Vanhoeffen from Dar es Salaam, and a mutilated specimen of a *Cephea* sp. by Menon (1930, p. 12) from the waters off Madras.

Sub-order DACTYLIOPHORÆ Stiasny, 1921.

Family Catostylidæ Stiasny, 1921.

(*Partim* Lychnorhizidæ Uchida, 1926.)

Genus *Crambionella* Stiasny, 1921.

Crambionella orsini (Vanhoeffen) Stiasny. (Pl. I, figs. 4 and 5 ; Text-figs. 12, 13 and 14.)

References :

Mastigias orsini E. Vanhoeffen, 1888, pp. 34, 35, pl. iv, figs. 2–4.
Crambionella orsini G. Stiasny, 1921, p. 129.
Crambionella orsini G. Stiasny, 1922*b*, p. 55.
Crambionella orsini G. Stiasny, 1923, pp. 232–235, fig. 2*a–c* ; fig. 3*a–c*.
Crambionella orsini M. G. K. Menon, 1930, p. 18, pl. iii, fig. 14*b* and *d*.

Occurrence :

Station ?, anchorage off Ras Khabbah, south-east coast of Arabia, 4.xi.33. Hand-net, surface.

6 specimens, smallest 55 mm. broad, largest 90 mm. broad. Well preserved, but the mouth-arms in every case torn away.

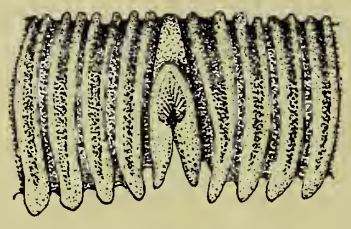
The gastro-vascular system plainly conforms to the *Crambione*-type. The arm-pillars are very broad, nearly three times as broad as the narrow slit-like, crescent-shaped sub-genital ostia. The colour is a uniform yellowish-brown, and one specimen, of 65 mm. breadth, shows a broad dark brown border ; the rhopalia bear no pigment ; they are all whitish and are very clearly visible between the surrounding darkly pigmented parts of the border. The long deep furrows, that run in a vertical direction to the border between the lappets, are whitish. All lappets are transparent, and some show the beginning of fission. Gonads in all specimens feebly developed.

Station ?, anchorage, Muscat, 22.xi.33. Hand-net, surface.

1 specimen, 72 mm. broad, 28 mm. high. Well preserved, but the mouth-arms badly damaged. Arm-pillars only twice as broad (20 mm.) as the ostia. The " arcade " of the network is always isolated, very high, hanging down so as to reach the border of the stomach. Colour, on the whole, bluish ; on the border of the ex-umbrella a broad violet zone ; lappets translucent, without pigment ; rhopalia whitish. On the border of the ex-umbrella many deep long furrows.

Station 70, off Jask, Gulf of Oman, 25.xi.33. Otter trawl, 196 metres.

1 specimen, 110 mm. broad, 43 mm. high. Colour uniformly brownish-yellow, only a little darker towards the border ; lappet zone transparent ; rhopalia without pigment. Mouth-arms bluish-yellow. Appendages about half the length of the under-arm.



Text-fig. 12.—(For comparison with Pl. I, fig. 4.)

Station 71, Straits of Hormuz, 26.xi.33. Otter net, 106 metres.

1 specimen, 88 mm. broad, 46 mm. high. Colour bluish-yellow with a pale violet border zone, upper arms with a pale violet hue. Appendages varying from $\frac{1}{3}$ to $\frac{1}{4}$ the length of the under-arm.

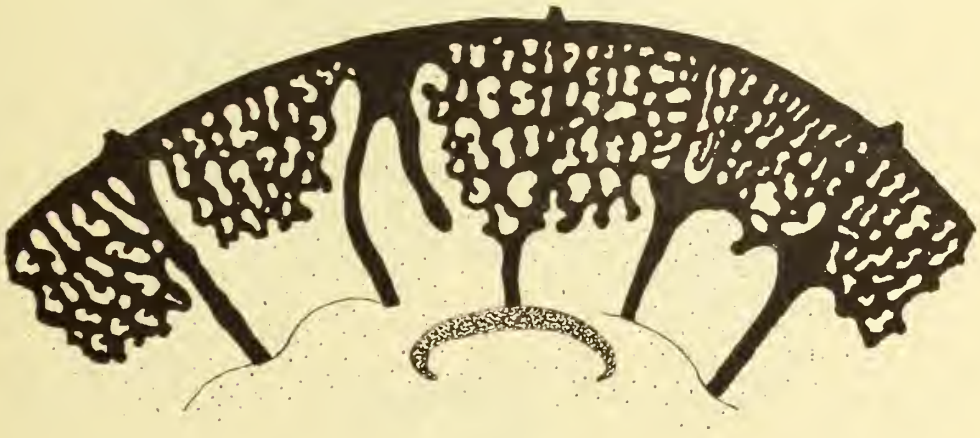
Station 75, Straits of Hormuz, 28.xi.33. Otter net, 201 metres.

3 specimens : (1) 90 mm. broad, 42 mm. high ; (2) 110 mm. broad, 40 mm. high ; (3) 115 mm. broad, 45 mm. high. One specimen uniformly light violet ; along the border two pigment zones of different colours, above a narrow circular stripe with irregular smaller or larger dark violet spots, often somewhat faded, and on the border a narrow dark violet ring with broad and deep white wedge-shaped furrows between and white furrows on the lappets ; lappets and rhopalia without pigment. Both the other specimens are much less pigmented ; the ex-umbrella is yellowish-brown, with a dark brown-violet ring-zone and pigmentless rhopalia and lappets. The mouth-arms are bluish-yellow ; the appendages are quite translucent with the canal-system distinctly visible. The gastro-vascular system (Text-fig. 14) is in all three specimens obviously strongly developed. The anastomoses are formed by unusually broad vessels, and look as though they had been injected with a whitish-yellow milk-like fluid. In the mesh-work of each arcade 3 or 4 canals, running radially and vertically to the ring-canal, are very obvious ; they are either all broader than the other lateral anastomoses, or are alternately thicker and thinner canals. In the extra-circular net 16 to 18 long canals, running vertically to the ring-canal, are

distinctly visible between the rhopalar canals. The terminal appendages on the mouth-arms are very variable in length. In the darkly pigmented specimen with dark spots they are quite rudimentary ; in the others so thickly covered with frills that a very small part only of the appendage remains naked. In one specimen they are about one-third of the length of the under-arm. Some of the mouth-arms are extremely short, only half as long as the others.

Station 76, off Muscat, 29.x.33. 2-metre diam. tow-net, 2500–0 metres (2800 metres of wire out).

3 specimens : (1) 85 mm. broad, 32 mm. high, well preserved ; (2) 70 mm. broad, 28 mm. high, well preserved ; (3) 72 mm. broad, 32 mm. high, without appendages. Gastro-vascular system typical, with very narrow network. Arm-pillars in all much broader than the ostia ; arm-disc very thick and high, in one specimen a vertical column of about 20 mm. high,



Text-fig. 13.

that is very similar to a patagium. Muscles very strongly developed, circular, interrupted in the rhopalar radii. Appendages of the mouth-arms very variable, plump, blunt pyramids, very short or nearly as long as the under-arm. Much less deeply pigmented than the examples from Ras Khabbah or the anchorage at Muscat ; the largest specimen of a yellowish-violet hue with a broad bright violet zone on the border ; lappets and rhopalia translucent. Mouth-arms and appendages yellowish. The other two examples greenish-violet, with a broad, pale, dull violet zone along the border ; mouth-arms, mouth-frills and appendages yellowish.

2 specimens : (1) 70 mm. broad, 35 mm. high. Under-arms rudimentary (not damaged), without appendages ; very pale brownish-yellow, with two pigment zones, the upper pigmented uniformly dark brown, the lower with smaller or larger irregular dark brown spots.

(2) 82 mm. broad, 48 mm. high. Brownish-yellow ; a strongly pigmented brownish-violet circular zone along the border, lappets and rhopalia translucent. Appendages approximately the same length as the under-arm. The gastro-vascular system of this specimen shows several abnormalities

(Text-fig. 13). From left to right there are (1) a fine meshwork, deep, hanging on one side of the rhopalar canal; (2) a normal network, somewhat extended on the right side; (3) an oblique inter-rhopalar canal debouching into a sinus-like enlargement of the ring-canal, from which arises a long blind outgrowth running obliquely towards the stomach; (4) a rhopalar canal bearing on each side a deep, fine-meshed network; (5) a forking inter-rhopalar canal, sending out a curved branch parallel to the border of the stomach towards the adjacent rhopalar canal and two stronger radial branches towards the ring-canal, all united by a dense irregular network of anastomoses; (6) a rhopalar canal connected in many places with the mesh-work. In three adjacent sectors a canal-system typical of *Catostylus* is represented. The other sectors show the typical high and isolated network (arcade), sometimes narrow, sometimes broader.

Measurements of one of the specimens:

Breadth of umbrella	105 mm.
Height of umbrella	52 ,,
Breadth of arm-disc	59 ,,
Height of arm-disc	21 ,,
Breadth of sub-genital ostia	22 ,,
,, of arm-pillars	31 ,,
Length of mouth-arms	62 ,,
Length of end-knob	25 ,,

Descriptive Notes.—The descriptions of this medusa by Vanhoeffen and Menon are not exhaustive, and in many respects are unsatisfactory. The present fresh material is in an excellent state of preservation, so that the descriptions can be completed, especially as regards the colour.

Jelly of the Umbrella.—*Crambionella orsini* is a plump, massive medusa, the jelly of which is opaque, hard and cartilaginous. A similar condition is present only in certain species of the genera *Catostylus* and *Stomolophus*. *Crambione* is always weak and tender, and is nearly transparent.

Size.—The size of the John Murray specimens, 55–110 mm. broad, is large in comparison with Vanhoeffen's type-specimen (65 mm.; *vide*, however, my observations on it, 1922, p. 232, footnote), but small in comparison with the measurements given by Menon. In the waters off Madras *Crambionella orsini* attains a breadth of 210 mm.

Border of the Umbrella (Pl. I, fig. 4, and Text-fig. 12).—The surface of the ex-umbrella is in most specimens finely granular, not plain, as stated by Vanhoeffen; the short pointed velar lappets are, however, smooth and number 16 in each octant. The rhopalar lappets are also plain, but are shorter, more pointed and diverge. Each velar lappet fuses above, *i. e.* towards the apex, in a relatively high thick ridge that is separated from the neighbouring one by a broad deep furrow of 5–6 mm. in length. On these ridges runs a wedge-shaped gully. On each side of the latter is a narrow ridge. Both ridges converge above each lappet, but do not reach the lappet itself. I have not previously observed this strange sculpturing (1922, text-fig. 2*c*), and neither has Menon seen it (1930, pl. iii, fig. 14*b*). The furrows between the lappets are always without

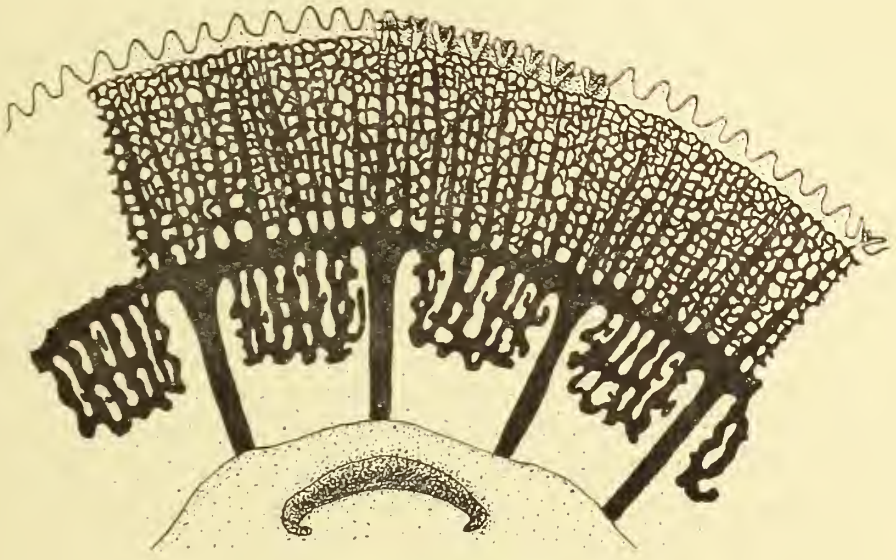
pigment and are, therefore, like the rhopalia, very obvious in the middle of the surrounding dark pigment. The rhopalia are separated from the adjacent velar lappets by slightly broader and deeper furrows. The sensory groove lies upon a rather thick slipper-shaped elevation of the jelly that extends upwards into a broad round ridge.

The *arm-disc* is very thick, massive and high, and sometimes resembles a patagium ; the upper arms, however, never fuse with it, but always remain free.

The *sub-genital ostia* have a very typical shape ; they are crescent-shaped slits, strongly narrowed by the thickened under-lip ; there are no subgenital papillæ. (Text-fig. 14).

The *muscles* are strongly developed, circular, interrupted in the rhopalar radii.

The *gastro-vascular system* (Text-fig. 14) in most specimens shows the typical *Crambione* type. The arcade is often very high, so long as to reach nearly to the border of the



Text-fig. 14.

stomach. In some specimens (for instance that from Station 75) the intra-circular network is strikingly well developed. Between the meshes there are 3 to 4 thicker radial vessels which run vertically to the ring-canal, or there are thicker and thinner canals alternating. In the extra-circular network of anastomoses there are, too, in each sector, numerous—16 to 18—radial canals running from the ring-canal to the periphery. The lappets are always free from network and there is no distinct peripheral ring-canal. The roundish warts, observed by me between the intra-circular network of the type-specimen (1922, p. 232, text-fig. 2B), could not be seen here. One specimen exhibited abnormalities of the gastro-vascular system (*vide supra*, p. 233, Text-fig. 13).

The mouth-arms.—Between the mouth-frills of the ab-axial side there are no appendages to be seen. On the axial side, however, there are small transparent buttons, mostly arranged in rows, in conformity with Vanhoeffen's description ; none, however, occurs above the terminal appendage. The terminal knobs vary extremely in shape and length. They are either almost rudimentary, their whole surface being covered with frills, or they may be almost as long as the under-arm, or only a half to a quarter the length of the same.

In all individuals the gastro-vascular system of the mouth-arms is distinctly visible owing to its whitish canals and anastomoses.

The *gonads* are in all the present examples very poorly developed.

Colour.—Menon, who had the advantage of studying the fresh colours of living specimens, records only a bluish-green. The present specimens, however, show a great variability of coloration ; some are very strongly and darkly pigmented ; others on the contrary are very pale. There are the following varieties :

(*a*) The ex-umbrella uniformly yellowish-brown with a broad dark brown band along the border.

(*b*) The ex-umbrella bluish-green with a broad dark violet zone along the border.

(*c*) The ex-umbrella pale yellowish-violet with a pale violet zone along the rim.

(*d*) The ex-umbrella uniformly pale violet with, towards the border, an upper narrow band of irregular, larger or smaller, deep violet or faded spots and a lower zone towards the lappets of a uniform dark violet colour.

The *sensory pits* and *radial furrows* on the border of the ex-umbrella are always very pale and without pigment ; the zone of the lappets is translucent.

The *mouth-arms* are yellowish-brown, rarely with a violet hue on the mouth-frills of the under-arms.

Some of the more deeply pigmented specimens remind one of the coloration shown in the beautiful figure of *Stomolophus meleagris* given by Mayer (1910, pl. lxxv, fig. 1).

Distribution.—*Crambionella orsini* has been recorded from Assab in the Red Sea (Vanhoeffen) from a few specimens only, but it is very common in the waters off Madras (Menon). It was, therefore, quite unexpected to find a relatively large number of this rare medusa in the John Murray hauls from localities so far north in the Arabian Sea as Muscat in the Gulf of Oman and in the Straits of Hormuz. The presence of this form at these widely separated localities cannot at the moment be explained satisfactorily (*vide* my remarks on p. 239, *infra*). All the specimens of *Crambionella orsini* from the Gulf of Oman were captured in the month of November at the surface, the only exception being the catch from Station 76 from 2000–0 metres depth. According to Schott (1918, pp. 10–12, table 2 ; and 1935, p. 214) there is, during the winter months (October–March), an outflowing surface current passing in a south-easterly direction out of the Persian Gulf into the Gulf of Oman. It is therefore not impossible that the specimens of *Crambionella orsini* captured in November in the Gulf of Oman may have had their origin in the Persian Gulf.

Rao (1931, pp. 50–55, pl. iii, pl. iv, fig. 1, text-figs. 4–8) described a new species of the genus *Crambionella*, *C. annandalei*, from the Andaman Sea. I, however, do not believe that this can be accepted as a good species. It agrees with *C. stuhlmanni* in respect of the tubercles on the velar lappets ; but, according to Rao, differs from it " only in the great length of the terminal club and its tapering form and in having small foliaceous appendages among the mouth-frills ". The present material of *C. orsini*, however, shows clearly to what a high degree the clubs may vary, and hence this feature cannot be regarded as a good character—a decision that also accords with my experience of *Mastigias* and *Acromitus*. The foliaceous appendages thus remain as the last difference between the two forms. The colour of the living animal is not recorded by Rao, but in the preserved condition it is a pale pink or cream. In view of these facts I cannot but regard *C. annandalei* as a doubtful species.

The very inaccurate description by Chun of *Crambessa viridescens* from the Pangani River, East Africa, is based on badly damaged specimens and, in fact, rests solely on the colour sketch by Stuhlmann (Chun, 1896, plate, fig. 2), that shows the umbrella to be of a vivid pale green (" seegrün ") colour and the mouth-arms pale with a light violet hue on the mouth-frills (the whole border having been torn away). Mayer (1910, p. 670) and the author (1921, p. 142) have recorded this medusa under the name *Catostylus viridescens*. The thorough study of the type-specimen, carried out by me (Stiasny, 1922*b*, pp. 49–50), was a very unsatisfactory one because of the bad state of preservation. From my study of the present material I believe that *Crambessa viridescens* Chun is a mutilated *Crambionella orsini*. Menon records the bluish-green colour of the bell in the living animal, and the present specimens are greenish too.

The old type-specimen, when I examined it, was greyish-yellow. The end-knobs are occasionally absent, as we know also in the case of *Mastigias* and *Acromitus*. The shape of the subgenital ostia, the very broad arm-pillars and the absence of subgenital papillæ agree perfectly with the present specimens. I thought, it is true, that I could recognize in the type-specimens, though not without some hesitation on account of the bad state of preservation, the canal type of *Catostylus*. Furthermore this medusa, *Crambessa viridescens*, was recorded from the Pangani River, which would be in accordance with my view.

? *Crambionella stuhlmanni* (Chun), recorded by Menon (*loc. cit.*, pp. 18, 19, pl. iii, figs. 14*a–c*) from the waters off Madras, is only an abnormal example (9 rhopalia, 14 velar lappets with conical outgrowths on the dorsal median line of the velar lappets) of *C. stuhlmanni*.

In conclusion I am inclined to adopt the view that there are only two good species in the genus *Crambionella*, namely, *C. stuhlmanni* (Chun), with a row of tubercles on the velar lappets, and *C. orsini* (Vanhoeffen) without tubercles, but with deep furrows on the lappets (the first species has knobs on the mouth-arms, while the second is with or without foliate appendages between the mouth-frills)—a difference that reminds one of *Atolla chuni* and *A. wyvillei*, that are respectively with and without glass-like beads on the velar lappets.

SOME REMARKS ON THE RELATION OF THE HYDROGRAPHY TO THE DISTRIBUTION OF THE SCYPHOMEDUSÆ IN THE ARABIAN SEA.

The Arabian Sea, with the exception of the Gulf of Aden and the Gulf of Oman, is, so far as its hydrography is concerned, almost unexplored (*vide* the splendid work of Schott, 1935, ' Geographie des indischen und stillen Ozeans '). For the hydrography of the two gulfs I refer the reader to papers by Schott (1918 and 1929), and to the publications of O. Krümmel (1911), F. Vercelli and M. Piçotti (1927), D. Matthews (1927 and 1928), Raphael del Buen (1927), A. Puff (1890), Luksch (1900), and Van Riel (1932).

With the exception of some short preliminary communications by Lieut.-Col. R. B. Seymour Sewell, the leader of the Expedition, published during the course of the expedition or soon after its return (*vide* the Bibliography at the end of this paper), the hydrographical results of the John Murray Expedition have not yet been published. Very little, therefore, can be said regarding the relationship between the hydrography and the distribution of the medusæ in the Arabian Sea in general ; and it is impossible to compare, as I had

hoped to do, the Scyphomedusan fauna on the north east and south-west sides of the Carlsberg Ridge that obviously divides the area into two different faunistic regions. Perhaps this may be done later. The two concentrations of medusæ, however, in the Gulf of Aden and the Gulf of Oman are so obvious and interesting that I feel obliged to try to give at least a preliminary explanation of the origin of both.

From the geographical point of view these two gulfs are very different. The Gulf of Oman is in open communication with the shallow Persian Gulf throughout from the surface to the bottom *viâ* the narrow Straits of Hormuz. No transverse ridge separates the two areas, the Straits of Hormuz being a deep fissure in the Oman chains that permits the transport of the entire water-column from the surface to the bottom into the Persian Gulf from the Gulf of Oman and *vice versâ*. The deep Red Sea, on the contrary, is tectonically shut off from the Gulf of Aden; north of Bab el Mandeb, near Great Hanish Island, there is a submarine threshold of about 100 metres in depth only. The currents in the Gulf of Oman are relatively simple, but in the Gulf of Aden we have to do with an extremely complicated system of currents caused by numerous submarine ridges on the floor of the sea, besides the seasonal changes in the direction of the currents caused by the monsoon and the tides.

In the Gulf of Oman there is during the months October to March an outflowing surface current, extending down to 30 to 70 metres, by means of which the water-masses are transported from the Persian Gulf *viâ* the Straits of Hormuz into the Gulf of Oman (*vide* Schott, 1918, table 2, p. 10; and Sewell, 1934, p. 669).

In the Gulf of Aden we find hydrographical conditions that are similar to those of the Straits of Gibraltar. According to the experience of Rafael del Buen (1927, p. 60) in this region we have, perhaps, to assume that the western deep current from the Red Sea is bent upwards before reaching the shallow sill near Great Hanish Island and runs backwards into the Red Sea again. From the Gulf of Aden surface water of relatively low salinity runs through the Straits of Bab el Mandeb into the Red Sea in compensation for the loss caused there in consequence of the extremely strong evaporation. At 100 to 150 metres' depth cooler water, but still warmer than 21° C., of about 39 to 40‰ salinity flows over the threshold into the Gulf. This component of the deep water-current entering the Gulf of Aden from the west is most probably very feeble and sinks in the Gulf down to 500 to 1000 metres' depth, exercising its influence, however, as far as the middle of the Gulf (Schott, 1935).* The hydrographical results of the John Murray Expedition, however, indicate that conditions had become reversed in the different cruises in spring and autumn (*vide* Sewell, 1934, pp. 137–138). In the Gulf of Aden itself a number of serial water samples and temperature readings indicate "a very complicated system of vertical rotation in the water-masses" in consequence of the ten transverse deep sea ridges in the Gulf.

Considering all these circumstances it seems rather improbable that the *Periphyllas* caught by the John Murray Expedition in the Gulf of Aden could have had their origin in the depths of the southern parts of the Red Sea, and that they had been carried out with the feeble outflowing deep-sea current. Moreover, neither *Periphylla* nor *Atolla* have been recorded hitherto from the Red Sea, and these medusæ being cold-water forms or forms

* The abnormally high temperatures below the surface in the Arabian Sea have been attributed to this source (Matthews, 1927, p. 512).

of moderate temperatures, it is extremely improbable that they will in the future be recorded from the warm deep waters of the Red Sea (*vide* also this Report, p. 220 and 222). So little, however, is known of the Scyphomedusan fauna of the Red Sea, and especially of its southern parts, that we cannot say with certainty whether the absence of the medusæ here is a fact, or is only apparent owing to the imperfect exploration of this area.

The occurrence of *Atolla* and *Periphylla* in a nearly continuous series of localities from Zanzibar along the East African coast to Cape Guardafui may, however, give a hint for another explanation of the origin of the medusæ in the Gulf of Aden. There is in this region, in the months August and September (Schott, 1935, table xxx), a strong current running in a north-east direction in consequence of the strong permanent winds, but restricted to a narrow stream along the coast, with small branches to the right due to the deviation caused by the rotation of the earth. In compensation cool water from the depths wells up towards the surface. To this cold upwelling water, perhaps, the presence of the cool-water medusæ in these coastal waters may be due. Both forms are recorded from Cape Guardafui too. It seems not impossible that a part of the deep-sea medusæ in the Gulf of Aden may have come from the south along the East African coast, carried along by the northward flow of the Socotra current, and have entered the Gulf between Socotra and Cape Guardafui (*vide* Puff, 1890, map 1).

It is rather improbable that the *Periphyllas* and *Atollas* of Zanzibar may be of antarctic origin. Sewell (1925) has shown that from the far south three large branches of antarctic water run very far north into the Arabian Sea. The western branch, however, is shown as ending in the latitudes of Madagascar, but Wüst (1934) has brought forward evidence to show that this deep bottom current can be traced up the African coast as far north as lat. 10° N.

Another possibility is, of course, that the medusæ in question may have originated in the Gulf of Aden itself and near Cape Guardafui. Most of the specimens of *Atolla* and *Periphylla* captured here are immature, with gonads but poorly developed. They must, therefore, have had their birthplace in the neighbourhood of these localities, and it is rather improbable that they can have undergone a long transport.

With regard to the medusæ in the Gulf of Oman, most of which were caught in November on the surface, it may be that they have been carried along with the south-east current coming from the Persian Gulf and that they have originated in this shallow sea. We know nothing at all, however, about the medusan fauna of this shallow area.

It is to be hoped that the publication of the hydrographical results of the John Murray Expedition will provide the required data for a more satisfactory and decisive explanation of the distribution of the medusæ in the Arabian Sea in general, and in both Gulfs in particular. There are still other interesting biological problems to be solved, for which, however, further exhaustive hydrographical data are indispensable. For instance, is it not strange that *Sanderia malayensis* suddenly appears in relatively large numbers near Suez, off Karachi and in the Gulf of Oman, this medusa being common in Philippine waters and the Malay Archipelago, and having hitherto been recorded only once in the Gulf of Aden ? Another problem is the sudden occurrence of *Crambionella orsini* in the Gulf of Oman, this medusa having been previously recorded in the waters off Madras and once only near Assab in the Red Sea ! Why is *Periphylla hyacinthina* apparently restricted to the western part of the Arabian Sea, and has never been recorded near the Maldives, Chagos Islands and the Seychelles, and only once from the Laccadives ; and whence comes the

relatively rich medusan fauna near Zanzibar ? Are its deep-sea components endemic, or are they carried by an eastern or southern current to and along the South-African coast ? This question is extremely interesting in view of the presence of the subtropical convergence just north of Zanzibar.

Finally the central part of the Arabian Sea shows some striking characteristics with regard to its hydrography. In the eastern part to the east of the Carlsberg Ridge there is a marked deficit of oxygen, that is already remarkable within a few metres of the surface. In depths of 500 to 600 metres there is a high salinity of about 35·5°/$_{oo}$ that is nowhere else recorded from similar depths in the Indian Ocean ; and during summer there is, in adaptation to the strong prevailing south-west wind and in accordance with the configuration of the coast, a monsoon current that runs clockwise round the central part of the Arabian Sea (*vide* Schott, 1935, p. 219, and pls. xxix and xxx).

Perhaps these facts, and others that may be deduced later on from the hydrographical results of the John Murray Expedition, may provide a more satisfactory explanation of the poorness of animal life in the central part of the Arabian Sea, that seems comparable in some respects with the condition present in the Sargasso Sea in the North Atlantic Ocean. Is it not obvious that most localities where medusæ occur are arranged along the periphery of this area, or is this merely a coincidence, and to be attributed to the comparatively small number of hauls that have been made in this region ? The central part of the Arabian Sea is likely to have, not only its own hydrographical character, but also its own rather poor fauna, and one that is somewhat different from that of the adjacent waters.

LIST OF REFERENCES.

A. Zoology.

Annandale, N. 1915. The Fauna of the Chilka Lake : Cœlenterates. Mem. Indian Mus., Calcutta, V, pp. 65, pls. vi–ix.

Bigelow, H. B. 1901–1904. Medusæ from the Maldive Islands. Bull. Mus. Comp. Zool. Harvard, XXXIX, pp. 245–269, pls. i–viii, 1 map.

—— 1928. Scyphomedusæ from the Arcturus Oceanographic Expedition. Zoologica, New York, VIII, 10, pp. 495–524, 5 figs.

Browne, E. T. 1905*a*. Scyphomedusæ. The Fauna and Geography of the Maldive and Laccadive Archipelagos, edited by J. S. Gardiner, II, pp. 958–971, pl. xciv.

—— 1905*b*. Report on the Medusæ. Rep. Pearl Oyster Fisheries of the Gulf of Manaar, by W. A. Herdman. Suppl. IV, pp. 131–166, pls. i–iv.

—— 1916*a*. Medusæ from the Indian Ocean (Percy Sladen Trust Expedition, " Sealark "). Trans. Linn. Soc. London, XVII, pp. 169–210, pl. xxxix.

—— 1916*b*. Notes on Some Jellyfishes from Okhamandal in Kattiawar. Rep. to the Gov. of Baroda on the Marine Zoology Okhamandal in Kattiawar, Pt. II, pp. 151–155.

—— 1926. Report on Medusæ. Trans. Zool. Soc., London, XXII, pp. 105–115.

Chun, C. 1896. Beiträge zur Kenntniss ost-afrikanischer Medusen und Siphonophoren nach den Sammlungen Dr. Stuhlmann's. Mitt. Naturh. Mus. Hamburg, XIII, Beiheft Jahrg. 1895, pp. 1–19, text illust.

Ekman, Sven. 1935. Tiergeographie des Meeres. Leipzig, pp. xii, 542, text illust.

Eschscholtz, Fr. 1829. System der Acalephen. Berlin, pp. iv, 190, 16 plates.

Goette, A. 1886. Verzeichniss der Medusen, welche von Dr. Sander, Stabsarzt auf S.M.S. " Prinz Adalbert " gesammelt wurden. S.B. Preuss. Akad. Wiss. Berlin, 1886, pp. 831–837.

Haeckel, E. 1879. Das System der Medusen ; mit Atlas. Denkschr. med.-naturwiss. Ges. Jena, I, pp. xxv, 672 ; Atlas, 40 pls.

Light, S. F. 1914. Some Philippine Scyphomedusæ, including Two New Genera, Five New Species and One New Variety. Philipp. Journ. Sci. Manilla, Sect. D, IX, pp.195–246 ; 1 pl., text illust.

Maas, O. 1903. Die Scyphomedusen der Siboga Expedition. Siboga Exped., Monographie XI, Leiden, pp. 91, 12 pls.

Mayer, A. G. 1910. Medusæ of the World : III, Scyphomedusæ. Carnegie Inst., Washington, Publ. 109, pp. iv, 499–735, pls. lvi–lxxvi, text illust.

—— 1917. Report upon the Scyphomedusæ collected by the U.S. Bur. of Fisheries Steamer "Albatross" in the Philippine Islands and Malay Archipelago. Bull. U.S. Nat. Mus., Washington, Bull. 100, I, pp. 175–233, text illust.

Menon, M. G. K. 1930. The Scyphomedusæ of Madras and the Neighbouring Coast. Bull. Madras Govt. Mus., New series Nat. Hist. Sect. III, pp. 1–29, pls. i–iii.

Rao, H. S. 1931. Notes on Scyphomedusæ in the Indian Museum. Rec. Indian Mus., Calcutta, XXXIII, pp. 25–62, pls. iii, iv, text illust.

Stiasny, G. 1919. Die Scyphomedusen-Sammlung des Naturhistorischen Reichsmuseums in Leiden : I, Die Carybdeiden (Cubomedusen). Zool. Meded., Leiden, V, pp. 33–58, text illust.

—— 1921. Studien über Rhizostomeen mit besonderer Berücksichtigung der Fauna des malayischen Archipels nebst einer Revision des Systems. Capita Zool. I, Afl. 2, pp. viii, 179, 5 pls., text illust.

—— 1922*a*. Die Scyphomedusen-Sammlung von Dr. Th. Mortensen aus dem Zoologischen Museum der Universität Kopenhagen. Papers from Dr. Th. Mortensen's Pacific Expedition, 1914–16. Vidensk. Medd. Dansk Naturh. foren., Kbh., Bd. 73, pp. 513–588, 14 text-figs.

—— 1922*b*. Ergebnisse der Nachuntersuchung einiger Rhizostomeen-Typen Haeckel's und Chun's aus den Zoologischen Museum in Hamburg. Zool. Meded., Leiden, VII, pp. 41–60, text illust.

—— 1923. Ergebnisse der Nachuntersuchung einiger Rhizostomeen-Typen Ehrenberg's, Haeckel's und Vanhoeffen's aus dem Zoologischen Museum in Berlin und Königsberg. Zool. Meded., Leiden, VII, pp. 225–242, 10 figures.

—— 1924. Scyphomedusen von den Molukken und den Kei-Inseln. Papers from Dr. Th. Mortensen's Pacific Expedition, 1914–1916. Vidensk. Medd. Dansk naturh. foren. Kbh. LXXVII, pp. 485–499, pls. i–iv, text illust.

—— 1934. Scyphomedusæ. "Discovery" Reports, Cambridge, VIII, pp. 329–396, pls. xiv, xv.

—— 1935. Die Scyphomedusen der Snellius Expedition. Verh. Akad. Wet. Amst. Afd. Natuurk., 2. Sect. XXXIV, 6, pp. 1–44, 1 pl.

Thiel, M. E. 1927. Die Scyphomedusen des Zoologischen Staatsinstituts und Zoologischen Museums in Hamburg : I, Cubomedusæ, Stauromedusæ und Coronatæ. Mitt. Zool. Mus. Hamburg, XLIII, pp. 1–34, text illust.

Uchida, T. 1929. Studies on the Stauromedusæ and Cubomedusæ with special Reference to their Metamorphosis. Jap. Journ. Zool. Tokyo, II, pp. 103–193, pls. iii–v, text illust.

Vanhoeffen, E. 1888. Untersuchungen über Semæostome und Rhizostome Medusen. Bibliogr. Cassel, I, Heft 3, pp. 52, pls. i–vi, 1 map.

—— 1892. Die Akalephen der Plankton Expedition. Ergebn. Plankton Exped. der Humboldt Stiftung, II, K. a. Kiel und Leipzig, pp. 30, 4 pls., 1 map.

—— 1903. Die acraspeden Medusen der Deutschen Tiefsee-Expedition "Valdivia". Wiss. Ergebn. "Valdivia", III, Jena, pp. 1–52, pls. i–viii.

—— 1908. Die Lucernariden und Scyphomedusen der Deutschen Südpolar-Expedition. Deutsche Südpolar-Expedition, X. Zoologie, II, pp. 25–50, pls. ii, iii, text illust.

b. Hydrography.

Buen, Rafael del. 1927. Rapport Atlantique pour 1926. Proc. verb., Cons. internat. pour l'éxploration de la mer, Copenhague, XLIV, pp. 60–91.

Krümmel, O. 1907. Handbuch der Ozeanographie, Pt. I, I–XV, pp. 1–526, 69 figs.

Luksch, J. 1898 and 1900. Physikalische Untersuchungen. Exp. v. S.M.S. "Pola" i. d. Rote Meer. Denkschr. Math. Nat. Kl. Akad. Wiss. Wien, Bd. 65 and 79.

Matthews, D. 1927 and 1928. Temperature and Salinity-observations in the Gulf of Aden. "Nature", CXX, p. 512 and CXXI, p. 92, 2 figs.

Moeller, Lotte. 1929. Die Zirkulation des Indischen Ozeans. Veröff. Inst. Meeresk. Univ. Berlin. Neue F. A. Geogr.-naturw. R., Heft 21, pp. 1–48, text illust.

Puff, A. 1890. Das kalte Auftriebwasser an der Ostseite des nord-atlantischen und der Westseite des nordindischen Ozeans. Dissert., Marburg, pp. 1–92, 2 pls.

Van Riel, P. M. 1932. Einige ozeanographische Beobachtungen im Roten Meer, Golf von Aden und Indischen Ozean. Ann. Hydr. LX, Jahrg. Heft X, pp. 6, 2 pls.

Sewell, R. B. Seymour. 1925. A Study of the Nature of the Sea Bed and of the Deep-sea Deposits of the Andaman Sea and Bay of Bengal. Mem. Asiatic Soc. Bengal, IX, No. 2, pp. 29–49, pls. vi, vii, text illust.

—— 1934. The " John Murray " Expedition to the Arabian Sea. Nature, Lond. CXXXIII, pp. 86–89, 669–672 ; CXXXIV, pp. 685–688.

—— 1934. The " John Murray " Expedition to the Indian Ocean. Geogr. Journ. LXXXIII, pp. 135–139.

—— 1935. Introduction and List of Stations, The John Murray Expedition, 1933–34. British Museum (Nat. Hist.) Scientific Reports, I, pp. 1–41, 1 pl., 1 map.

Schott, G. 1918. Ozeanographie und Klimatologie des Persischen Golfes und des Golfes von Oman. Beil. Ann. Hydrogr. Berlin (consult this paper for further literature), XLVI, pls. i–vii, text illust.

—— 1929. Ueber die Wasserbewegungen im Bab el Mandeb. Beil. Ann. Hydrogr. Berlin, LVII, pp. 10–14, text illust.

—— 1935. Geographie des Indischen und Stillen Ozeans. Hamburg, pp. xix, 413, 1 pl., 37 charts, text illust.

Vercelli, F., and Picotti, M. Istituto Idrografico della R. Marina. Campagna nel Mar Rosso " Ammiraglio Managhi ". Ricerche di oceanografia per F. Vercelli, Parte I, Correnti e maree, 1925 ; Parte IV. La temperatura e la salinità. Genova, 1927. Ricerche di oceanografia chimica per M. Picotti, parte I. Tabelle delle analisi clorometriche e dei dati di temperatura. Genova, 1927.

Wüst, G. 1934. Anzeichen von Beziehungen zwischen Bodenstrom und Relief in der Tiefsee des Indischen Ozeans. Naturwissenschaften, 22 Jahrgang, Berlin, pp. 241–244.

DESCRIPTION OF PLATE.

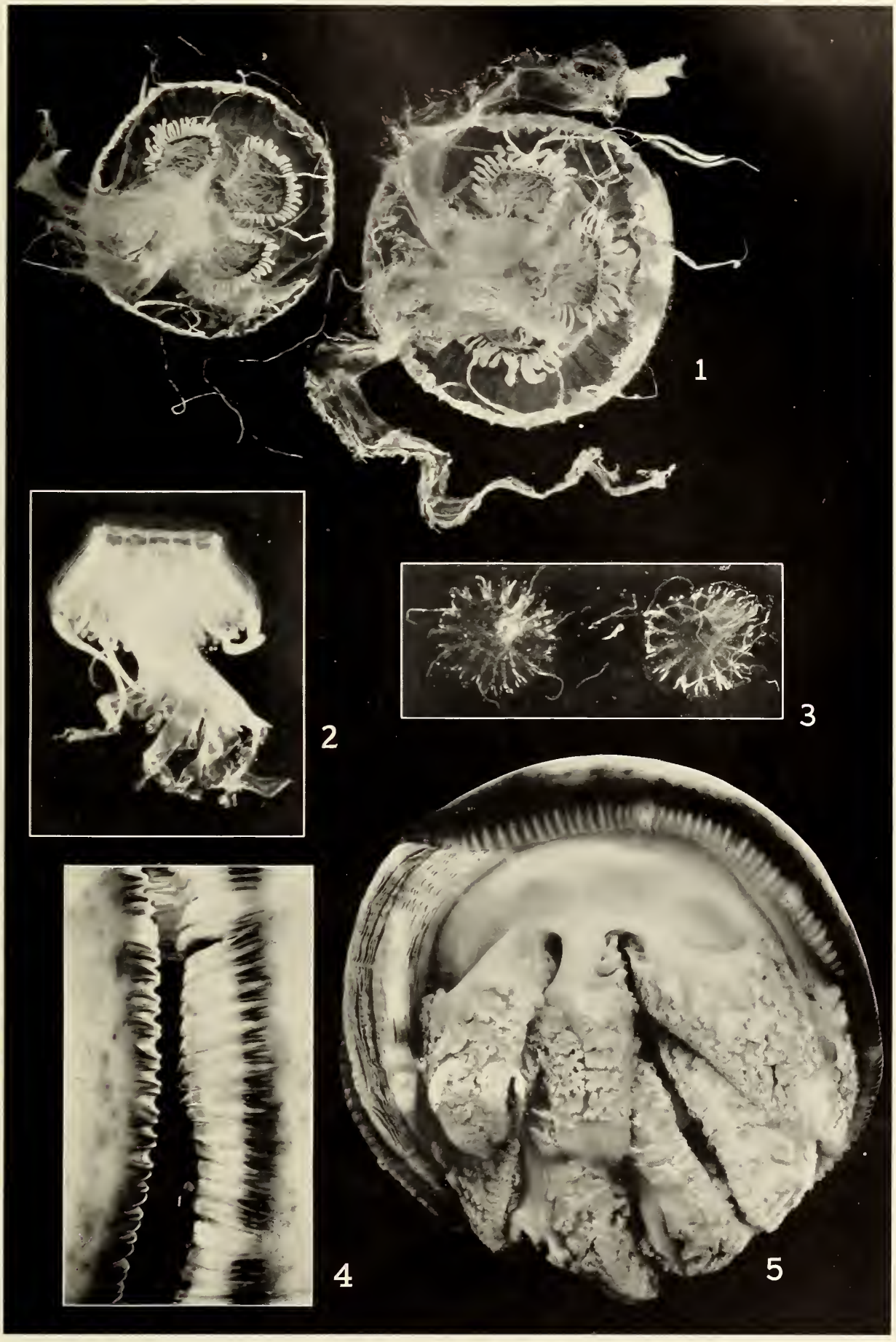
Fig. 1.—*Sanderia malayensis* Goette. Natural size. Sub-umbrellar view.

Fig. 2.—*Sanderia malayensis* Goette. *Pelagia*-stage. Side view. × 3.

Fig. 3.—*Sanderia malayensis* Goette. Post-ephyral stages. × 5.

Fig. 4.—*Crambionella orsini* (Vanhoeffen) Stiasny. (On the left sculpture on the lappets, on the right furrows between and form of the lappets.) × 5.

Fig. 5.—*Crambionella orsini* (Vanhoeffen) Stiasny. Sub-umbrellar view. Natural size.



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NATURAL HISTORY

Scyphomedusæ: Distribution in Arabian Sea

Previous Records

- Atolla wyvillei
- Aurelia colpota
- ⊙ – maldivensis
- ⊗ – solida
- △ Cassiopea andromeda
- \+ Cephea
- □ Chiropsalmus quadrigatus
- Crambessa viridescens
- Crambionella orsini
- M Mastigias siderea
- ✳ Nausithoë punctata
- ✳ Netrostoma coerulescens
- ○ Pelagia flaveola
- ● – noctiluca
- Periphylla hyacinthina
- ○ Sanderia malayensis
- ✧ Tamoya alata

EGYPT
CAIRO
SUEZ
EL HEJAZ
JIDDA
PORT SUDAN
RED SEA
SUAKIN
ANGLO-EGYPTIAN SUDAN
HASSAWA
EL HASA
OMAN
MUSCAT
ARABIA
HADRAMAUT
YEMEN
ADEN
Ras Fartak
Socotra
Guardafui
BERBERA
SOMALILAND
C A
MUSCAT
KARACHI
BOMBAY
I N D I A
Laccadive Is
Minikoi
COLOMBO
Maldive Is
I N D I A N
O C E A N
Chagos Archipelago
Amirante Is
Mahé
Seychelles
Cosmoledo I.
Aldabra Is
(Cert.)
Pemba
ZANZIBAR
COLONY
MOMBASA
TANGANYIKA TERRITORY
Mafia

MAP I.

MAP I.

BRITISH MUSEUM (NATURAL HISTORY)

THE

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SCIENTIFIC REPORTS

VOLUME IV, No. 8

30 JUN 1937
PRESENTED

POLYCHÆTA

BY

C. C. A. MONRO, M.A.
(Assistant Keeper in the Department of Zoology)

WITH TWENTY-EIGHT TEXT-FIGURES

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WITH TWENTY-EIGHT TEXT-FIGURES.

INTRODUCTION

The present collection was obtained in the Red Sea and the Arabian Sea, in the Gulfs of Aden and Oman, off the South Arabian Coast, and in the Zanzibar and Maldive areas. Except for a few nereids taken on the shore of the South Arabian Coast, there was no littoral collection made, but all the material was obtained from coastal or deep-water positions.

There follows a list of species :

Family Amphinomidæ.

Euphrosyne foliosa Audouin and Milne-Edwards.
Benthoscolex cæcus Horst.
Notopygos sp.
Pseudeurythoë acarunculata n. sp.
P. ambigua (Monro).
Eurythoë complanata (Pallas).
Chloeia tumida Baird.
C. fusca McIntosh.
C. violacea Horst.

Family Aphroditidæ.

Lætmatonice producta Grube var. *benthaliana* McIntosh.
Aphrodite talpa Quatrefages.
Hermione hystrix (Savigny).
Aphrogenia alba Kinberg.

Family Polynoidæ.

Harmothoë cornuta (Potts).
H. arabica n. sp.
H. lunulata (Delle Chiaje).
Hololepidella commensalis Willey.
Eunoë pallida (Ehlers).
Allmaniella sp.
Nectochæta caroli Fauvel.
N. grimaldii Marenzeller.

Family Sigalionidæ.

Sigalion mathildæ Audouin and Milne-Edwards.
Leanira vulturis Horst.
L. japonica McIntosh.
Euthalanessa djiboutiensis (Gravier).

Family Polyodontidæ.

Polyodontes melanonotus (Grube).
Polyodontes sp.
Panthalis œrstedi Kinberg.

Family Chrysopetalidæ.

Chrysopetalum occidentale H. P. Johnson.

Family Phyllodocidæ.

Phyllodoce madeirensis Langerhans.
Notophyllum splendens (Schmarda).
Eulalia tenax Grube.
Lopadorhynchus uncinatus Fauvel.
L. brevis Grube.
L. brevis Grube var. **nuchalis** var. nov.

Family Alciopidæ.

Rhynchonerella fulgens Greeff.
Vanadis formosa Claparède.

Family Tomopteridæ.

Tomopteris (*Johnstonella*) *dunckeri* Rosa.
T. (*Johnstonella*) *duccii* Rosa.
T. cavallii Rosa.
T. planktonis Apstein.

Family Hesionidæ.

Hesione intertexta Grube.

Family Syllidæ.

Syllis variegata Grube.
S. gracilis Grube.
S. krohnii Ehlers.
S. brachychæta Schmarda.
S. curticirris n. sp.
Syllis sp.
S. (*Haplosyllis*) *spongicola* Grube.
S. (*Ehlersia*) *cornuta* Rathke.
Trypanosyllis zebra Grube.
Parasphærosyllis indica gen. et sp. nov.

Family Nereidæ.

Nereis jacksoni Kinberg.
N. zonata Malmgren var. *persica* Fauvel.
N. longilingulis n. sp.
Platynereis pulchella Gravier.
Ceratonereis mirabilis Kinberg.
Leonnates jousseaumei Gravier.

Family Nephthydidæ.

Nephthys dibranchis Grube.
N. inermis Ehlers.

Family Glyceridæ.

Glycera rouxii Audouin and Milne-Edwards.
G. subœnea Grube.
G. lancadivæ Schmarda.
Goniada multidentata Arwidsson var. **indica** var. nov.
G. eximia Ehlers.
G. longicirrata Arwidsson.

Family Eunicidæ.

Eunice indica Kinberg.
E. australis Quatrefages.
E. antennata Savigny.
E. tentaculata Quatrefages.
E. validobranchiata n. sp.
E. investigatoris Fauvel.
Marphysa simplex Crossland.
Lysidice collaris Grube.
Onuphis furcatoseta n. sp.
O. aucklandensis Augener.
O. eremita Audouin and Milne-Edwards.
Onuphis sp.
Diopatra neapolitana Delle Chiaje.
Hyalinœcia tubicola (O. F. Müller).
Rhamphobrachium bipes n. sp.
R. diversosetosum n. sp.
Lumbrinereis latreilli Audouin and Milne-Edwards.
L. impatiens Claparède.
L. heteropoda Marenzeller.
L. quasibifilaris n. sp.
Drilonereis filum Claparède.

Family Spionidæ.

Prionospio pinnata Ehlers.

Family Magelonidæ.

Magelona sp.

Family Chætopteridæ.

Phyllochætopterus sp.

Family Cirratulidæ.

Cirratulus sp.
Chætozone setosa Malmgren.

Family Chlorhæmidæ.

Stylarioides xanthotrichus (Schmarda).
S. hamocarens n. sp.
Brada villosa (Rathke).
Flabelligera diplochaitos (Otto).
Ilyphagus hirsutus n. sp.

Family Capitellidæ.

Notomastus latericeus Sars.
Dasybranchus caducus Grube.

Family Maldanidæ.

Maldane cristata Treadwell.
M. sarsi Malmgren var. **tropica** var. nov.
Notoproctus pacificus (Moore).
Clymene (*Praxillella*) *gracilis* (Sars).
Clymene sp.
Clymenella sp.
Nicomache sp.
Petaloproctus cirratus n. sp.

Family Oweniidæ.

Owenia fusiformis Delle Chiaje.

Family Sabellariidæ.

Sabellaria spinulosa Leuckart.
S. spinulosa Leuckart var. *alcocki* Gravier.

Family Ampharetidæ.

Amphicteis gunneri Sars.

Family Terebellidæ.

Thelepus comatus (Grube).
Nicolea gracilibranchis (Grube).
Polymnia nebulosa (Montagu).
Loimia medusa Savigny.
Pista herpini Fauvel.
P. typha (Grube).
P. robustiseta Caullery.

Family Sabellidæ.

Demonax leucaspis Kinberg.
Dasychone cingulata Grube.
Branchiomma mushaensis Gravier.
Euratella puncturata (Augener).

Family Serpulidæ.

Serpula vermicularis L.
Hydroides exaltata (Marenzeller) var. *vesiculosa* Fauvel.
H. homoceros Pixell.
Spirobranchus giganteus Pallas.
S. giganteus var. **arabica** var. nov.
S. maldivensis Pixell.
Vermiliopsis glandigera Gravier.
V. acanthophora Augener.
V. multicristata (Philippi).
Placostegus tridentatus (Fabricius).
Ditrupa arietina (O. F. Müller).

The total number of species or varieties is 133, belonging to 83 genera. The proportion of new forms is high, for there are 1 new genus, 13 new species and 4 new varieties, and this is probably to be explained by the fact that much of the material was obtained from very considerable depths.

Fauvel has recently (1932) published under the title of " The Annelida Polychæta of the Indian Museum " a comprehensive paper on the Indian Ocean Polychæta, in which he gives a diagnosis, with ample citations and lists of synonyms, of every species represented. He also provides a full list of the literature of the Indian Ocean Polychæta. A large proportion of the species in the present collection is to be found in Fauvel's Indian Museum material, and to obviate reduplication I have simply given the reference to Fauvel's paper when the same species is present in both collections.

Apart from new forms, the following species were not represented in the Indian Museum collection :

Pseudeurythoë ambigua.
Chlœia tumida.
C. violacea.
Harmothoë cornuta.
H. lunulata.
Nectochæta caroli.
N. grimaldii.
Leanira vulturis.
Sigalion mathildæ.
Chrysopetalum occidentale.
Notophyllum splendens.
Lopadorhynchus brevis.
Rhynchonerella fulgens.
Vanadis formosa.
Tomopteris (*Johnstonella*) *dunckeri.*
T. (*J.*) *duccii.*
T. cavallii.
T. planktonis.
*Syllis krohnii.**
S. (*Ehlersia*) *cornuta.**
Platynereis pulchella.
Nephthys inermis.
Glycera subœnea.
Goniada eximia.
G. longicirrata.
Marphysa simplex.
Chœtozone setosa.
Stylarioides xanthotrichus.
Brada villosa.
Flabelligera diplochaitos.
Maldane cristata.
Notoproctus pacificus.
Thelepus comatus.
Demonax leucaspis.
Branchiomma mushaensis.
Euratella puncturata.
Hydroides exaltata var. *vesiculosa.*
H. homoceros.
*Vermiliopsis glandigera.**
*V. acanthophora.**
V. multicristata.
Placostegus tridentatus.

The Amphinomids are represented by nine species, among which there is a small eyeless *Notopygos* from a depth of over 1200 m., a new species devoid of a caruncle of Fauvel's recent genus *Pseudeurythoë*, and a representative of *Pseudeurythoë ambigua* previously known only from the Panama region. The Polynoids yielded several deep-water examples, one of which I have attributed to *Harmothoë cornuta* and another to *Allmaniella* ; there is a new *Harmothoë* with smooth dorsal and upper ventral bristles, and two pelagic members of the family are represented, *Nectochæta caroli* and *N. grimaldii*. Among the Polyodontids there is a young *Polyodontes* which appears to combine the characters of *P. melanonotus* and *P. maxillosus*. The single Chrysopetalid agrees with Johnson's *Ch. occidentale* from the Californian coast, which is probably the same as the

* Those marked with an asterisk are represented in Fauvel's (1930) ' Littoral Fauna of Krusadai Island, Gulf of Manaar '.

European *Ch. debile* Grube. Among the Phyllodocids Grube's pelagic Mediterranean *Lopadorhynchus brevis* is represented, and also a *Lopadorhynchus* with very conspicuous nuchal organs.

There are four species of Tomopterids, among which is *Tomopteris* (*Johnstonella*) *duccii*, remarkable for having three distinct kinds of pedal glands and a sting.

There are two new species and one new genus of Syllids, the new genus being distinguished by having over part of the body slender, moniliform dorsal cirri alternating with smooth, swollen dorsal cirri; the new species has dorsal cirri with only three to four articles.

Among the Nereids the new *N. longilingulis* has extraordinarily long, cirriform pedal languets, and I am able to relate a curious heteronereid showing the *polyscalma* type of modification to *Platynereis pulchella*.

There are five species of Glycerids, and among them there is an example from a depth of over 1519 m. of the Magellan, cold-water *Goniada eximia*. The Eunicids are represented by 21 species, among which the new deep-water *Eunice validobranchiata* has an extraordinary development of gill. Fauvel's recent *E. investigatoris* was also obtained from a depth of over 1000 m. There is a new deep-water *Onuphis* with ramified woolly gills and curious, forked, anterior hooks. There are two new species of the rare *Rhamphobrachium*, one of which has only the first two feet modified, and a new *Lumbrinereis* with long, paired, cirriform pedal ligules and compound anterior hooks.

The Magelonids are represented by a pelagic post-larva, and among the Cirratulids there is an example of the northern European *Chætozone setosa* not previously recorded from tropical waters.

The Chlorhæmids have five species, among which is a new *Stylarioides* entirely devoid of hooks and an example of the rare deep-water genus, *Ilyphagus*.

The Maldanids include specimens of Treadwell's Californian *Maldane cristata* and Moore's *Notoproctus pacificus*, previously known from the neighbourhood of Vancouver Island, a new variety from below the 1000 m. line of *Maldane sarsi*, and a new *Petaloproctus* with a cirrigerous anal plate. Among the Terebellids is an example of *Thelepus comatus* previously known from Chile and the Panama region. The Sabellids include examples of the curious *Euratella puncturata* known from the West African coast, and among the Serpulids there are a new variety of *Spirobranchus giganteus* with small chitinous hooks on the operculum, and an example of the European *Placostegus tridentatus*.

Fauvel has already called attention to the number of species common to the Indian Ocean and to the Atlantic and Mediterranean, and has often emphasized the fact that many Polychætes have a cosmopolitan distribution.

It is perhaps worth calling attention to the great variety of species obtained at two stations, St. 45, South Arabian Coast, depth 38 m., bottom lithothamnion, and St. 53, South Arabian Coast, depth 13·5 m., bottom rock, shingle, shells and lithothamnion. Examples of no less than 38 species were taken at one or both of these two stations.

SYSTEMATIC ACCOUNT

Family Amphinomidæ.

Genus *Euphrosyne* Savigny.

Euphrosyne foliosa Audouin and Milne-Edwards.

Fauvel, 1923, p. 136, fig. 49 *a–g*, and 1932, p. 59, with synonymy.

Occurrence :

St. M.B. Id, Red Sea, 26 m. (1).

St. 10, Red Sea, 55 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Remarks.—The tips of the gills are expanded. The specimen from St. 10 has a pale yellow body colour and wine-red gills and caruncle. The other specimen has the usual greyish colour in spirit. Fauvel has identified this European species with the *E. laureata* Savigny of Horst, Pruvot and Gustafson.

Genus *Benthoscolex* Horst.

Benthoscolex cæcus Horst.

Horst, 1912, p. 38, pl. x, figs. 11–16.
Fauvel, 1932, p. 54.

Occurrence :

St. 177, Gulf of Aden, 274–366 m. (9).

Distribution.—Flores Sea, Ceylon, Indian Ocean.

Remarks.—The largest specimen measures 40 mm. by 7 mm. at the widest part without the feet for 31 chætigers. Except in one or two details they agree with Horst's account. The gills begin with a minute bifurcate filament on the 5th chætiger. Horst states that there is an unpaired anal cirrus. This I have not seen. The anus consists of a subterminal, dorsally truncated cleft extending over the last 3 or 4 chætigers. It is hidden by the greatly developed clusters of gills (Text-fig. 1*a*), and the terminal segments which it occupies are very crowded and difficult to count.

Text-fig. 1.—*Benthoscolex cæcus* Horst. *a*, Terminal segments from above. *b*, Anal segments from above. Gill removed from penultimate segment.

The body appears to end with a pair of modified parapodia fused with the ventral lip of the anus (Text-fig. 1*b*). These parapodia each consist of a rudimentary branched gill, a single very small bristle-bundle and a very long ventral cirrus. I can see no unpaired anal cirrus, nor can I follow Horst when he speaks of "an unpaired anal papilla, faintly emarginated".

Genus *Notopygos* Grube.

Notopygos sp. juv.

Occurrence :

St. 119, Zanzibar, 1207–1463 m. (1).

Remarks.—This small specimen from below the 1000 m. line measures 9 mm. by 3 mm. at the widest part for about 15 chætigers. It is much damaged, and the terminal segments cannot be counted exactly. The distinctive feature is the complete absence of eyes. There is a broad caruncle extending to the 4th chætiger. The gills begin on the 5th. The bristles are damaged.

Genus *Pseudeurythoë* Fauvel.

Pseudeurythoë acarunculata n. sp.

Occurrence :

St. 160, Maldives, 37 m. (1).

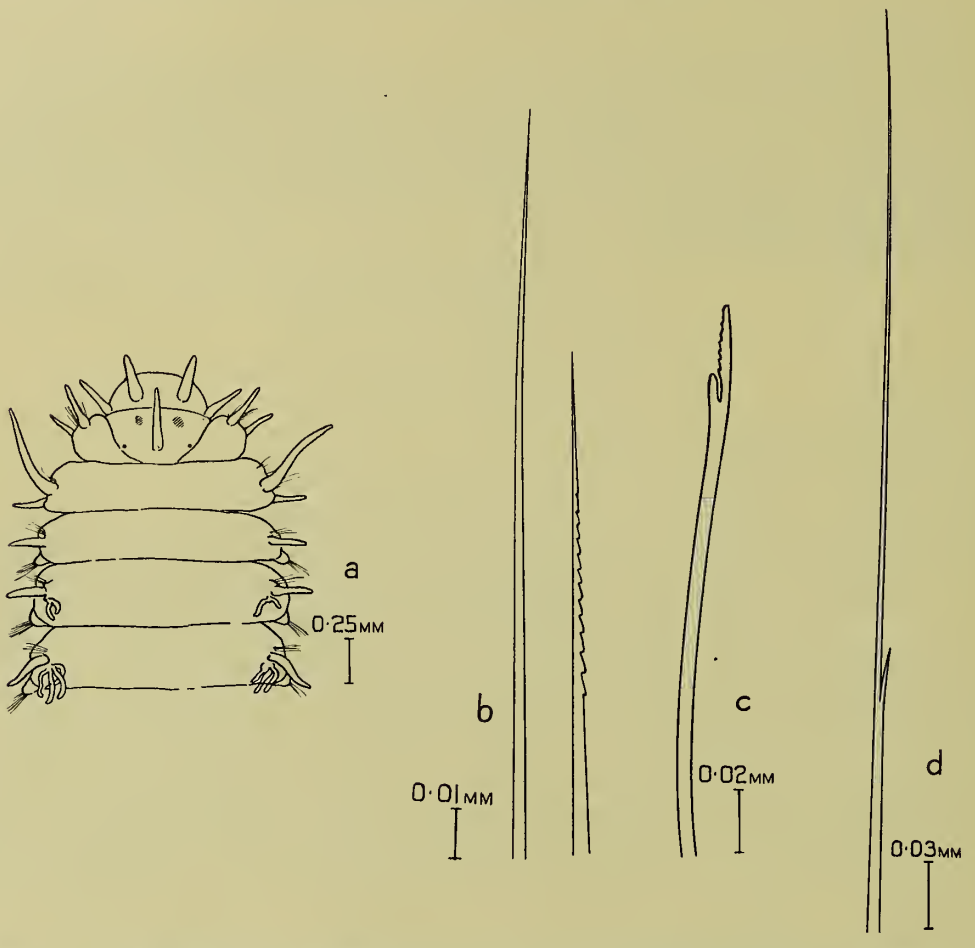
Distribution.—Maldives.

Description.—The single specimen is tightly coiled and brittle, so that an accurate measurement is impracticable. It is incomplete posteriorly, and measures about 30 mm. by 1 mm. for about 75 chætigers. The body-shape is very slender and vermiform. There is no colour. The head (Text-fig. 2*a*) is more or less rectangular in outline and divided into two regions by a transverse groove. It is deeply retracted into the first segments, and at the sides the first chætiger is on a level with the transverse groove and in contact with the bases of the palpophores. The hinder part of the prostomium is slightly broader than long and cut off squarely behind. *I can see no trace of a caruncle.* The back of the head is surrounded by the first chætiger, and when this is forced back there appears to be a kind of nuchal pit, but there is no sign of a raised area. The lateral tentacles lie just anteriorly to the transverse groove and reach back to the end of the head. The median tentacle is a little larger, and lies in the posterior half of the hinder part of the head. The palpostyles are lateral, and are situated just in front of the bristle-bundles of the first chætiger. There are two pairs of rather indistinct eyes, the front pair just behind the lateral tentacles and the hinder pair rather more lateral and on a level with the median tentacle. The first two chætigers are involved with the mouth. There are no hooks in the first chætiger.

The gills begin on the 4th chætiger, form fairly conspicuous bushy tufts in the anterior region, gradually taper away towards the middle of the body and disappear by the 50th chætiger.

The dorsal ramus of the feet is small and inconspicuous, and the bristles, which are few in number, come straight out of the body-wall. There is an elongate dorsal cirrus. The ventral ramus forms a low lobe about as long as the ventral cirrus, and has a much larger bristle-bundle than the dorsal ramus. The condition of the bristles is poor. The

dorsal bristles (Text-fig. 2*b*) are few, short and inconspicuous. They consist of very fine capillary bristles probably smooth towards the tips and a few rather stouter, but still delicate harpoon bristles, from which the teeth have for the most part disappeared. The ventral bristles are of two kinds, relatively short and stout bristles with a well-marked spur (Text-fig. 2*c*) and a denticulated tip, and very long and fine capillary bristles (Text-fig. 2*d*) with a small spur closely apposed to the main limb. These bristles have serrated ends. Simple capillary bristles without a spur appear to be absent, for all the capillary bristles in the ventral ramus seem to be furcate.



TEXT-FIG. 2.—*Pseudeurythoë acarunculata*. *a*, Anterior end from above. *b*, Dorsal bristles. *c*, Ventral bristle, stouter type. *d*, Ventral bristle, finer type.

REMARKS.—Both *Linopherus canariensis* Langerhans and *Paramphinome oculifera* Augener, which Fauvel justly refers to his recent genus *Pseudeurythoë*, are described as being without a caruncle. They both appear to be considerably smaller than the present species, and have the gills beginning on the 3rd and ending on about the 10th chætiger.

In its general facies and especially in the retraction of the head in the first segments the present species agrees with *Ps. microcephala* Fauvel, but differs in the absence of a caruncle, in having gills continued further over the body and in having furcate ventral capillary bristles. The position of the species must remain doubtful at present, and awaits further investigation in the light of better material.

Pseudeurythoë ambigua (Monro).

Eurythoë ambigua Monro, 1933, p. 6, text-fig. 2.

Occurrence :

St. 142B, Maldives, 37 m. (2).

Distribution.—Gulf of Panama, Maldives.

Remarks.—Shape slender and vermiform, tapering rather sharply in front and gradually behind. The type-specimen from Taboga Island measures 47 mm. by 2 mm. at the widest part for 82 chætigers. The present material consists of two anterior fragments, one measuring 12 mm. by 2 mm. for 28 chætigers, and the other 7 mm. by 1 mm. for 19 chætigers. The head (*v.* Monro, *loc. cit.*, fig. 2) is rounded in front, divided into two regions by a transverse groove running a little way behind the lateral tentacles, and is more or less rectangular, broader than long, behind (Text-fig. 3*a*). The hinder part is not heart-shaped as in *Ps. paucibranchiata* Fauvel.

Text-fig. 3.—*Pseudeurythoë ambigua* (Monro). *a*, Anterior end from above (eyes not shown). *b*, Dorsal bristles. *c*, Ventral bristles.

The caruncle consists of a rounded pad lying in the first chætiger. There are two pairs of eyes, which are very obscure, and in one of the present specimens invisible. One pair lies just behind the lateral tentacles, and the other at the sides of the head just in front of the median tentacle. The tentacles and palpostyles are about as long as the prostomium is broad and all more or less equal.

The first two chætigers carry conspicuous dorsal and ventral cirri and on the ventral side are involved with the mouth. The gills begin as small tufts on the 3rd chætiger (on the 4th in the smaller fragment), and rapidly increase in size till by the 5th chætiger they are large and conspicuous buncles of filaments. In the type they cease at the 44th chætiger, and in the larger of the two present fragments they are considerably reduced by the last (28th) chætiger, but still show about 5 filaments.

The notopodium is less prominent than the neuropodium, in which the lips of the chæta-sac form a projecting lobe a little shorter than the slender ventral cirrus. There are no hooks in the first chætiger, and the bristles are all very delicate. There is an elongate dorsal cirrus. The dorsal ramus has slender, white harpoon bristles and long, exceedingly fine capillary bristles apparently smooth at the ends (Text-fig. 3*b*). The ventral ramus carries (1) relatively stout, rather short bristles with a well-marked spur and clearly denticulated end-piece, (2) very long and fine capillary bristles similar to those in the notopodium except that they have denticulated ends, and (3) a number of capillary bristles with a very delicate spur closely apposed to the long arm (Text-fig. 3*c*). In regard to these last upper furcate capillary ventral bristles, they cannot be seen in the type; they appear to be very scarce, and are very difficult to find in the larger of the two present fragments, but in the smaller they are numerous and easily seen. As this last specimen is much smaller than the rest, a possible explanation may be that they disappear with age, but the condition of the bristles in the type is so poor that the absence of the slender, ventral, furcate kind cannot be asserted.

Remarks.—More material is required for the thorough understanding of the characters of this species. Except for the presence of the slender, furcate bristles these specimens agree with my *ambigua* more closely than with Fauvel's Indian Ocean *paucibranchiata*, but I am not convinced that the two species will not in the end prove to be identical. The chief differences are (1) the shape of the hinder part of the prostomium and (2) the distribution of the gills. In Fauvel's species the hinder part of the prostomium is heart-shaped, and in *ambigua* it is broader than long, more or less rectangular. It should be said, however, that all the specimens attributed by me to this species have the proboscis more or less extruded, and this is apt to cause changes in the shape of the prostomium. In *paucibranchiata* the gills cease at about the 25th chætiger, and in my species at about the 45th. With our present very imperfect knowledge of these two species it is better to keep them apart.

Genus *Eurythoë* Kinberg.

Eurythoë complanata (Pallas).

Fauvel, 1932, p. 45, with synonymy.

Occurrence:

St. M.B. Ic, Red Sea, 26 m. (1).

Distribution.—Tropical Atlantic, Indian and Pacific Oceans.

Genus *Chlœia* Savigny.

Chlœia tumida Baird ?.

Baird, 1868, p. 232, pl. iv, fig. 7 *a–d*.
Fauvel, 1917, p. 191.
Chlœia flava var. *tumida* Monro, 1931, p. 35.

Occurrence :

St. 147, Maldives, 27 m. (3).

Distribution.—North Australia, Singapore, Maldives.

Remarks.—These are young Chlœias, the largest of which measures 6 mm. by 1 mm. without the bristles for 18 chætigers. One specimen shows a little violet pigment on the median tentacle ; otherwise except for the eyes they are quite colourless. The bristles are very fine, and too much damaged for identification. These specimens may be young examples of Baird's species.

Chlœia fusca McIntosh.

McIntosh, 1885, p. 14, pl. ii, figs. 1, 2.
Fauvel, 1932, p. 56, with synonymy.

Occurrence :

St. 27, Gulf of Aden, 37–91 m. (1).

St. 43, South Arabian coast, 83–100 m. (2).

St. 111, Zanzibar, 73–165 m. (1).

St. 178, Gulf of Aden, 91 m. (1).

Distribution.—Australia, China, Bay of Bengal, Gulf of Aden.

Remarks.—The gill begins on the 5th chætiger and not on the 4th as in the *flava* group of species. All the specimens have a yellowish body colour and a pair of purple longitudinal dorsal stripes showing various degrees of fading.

Chlœia violacea Horst.

Horst, 1912, p. 22, pl. vii, fig. 8, pl. viii, figs. 8–11.

Occurrence :

St. 74, Gulf of Oman, 155 m. (3).

Distribution.—Malay Archipelago, Gulf of Oman.

Remarks.—Body fusiform. The caruncle extends to the 4th chætiger and the gills begin on this segment. The body colour is a pale yellow. In each segment there is a violet, or in faded specimens an orange, spot shaped like an inverted T, the transverse arm of which lies just in front of the hinder intersegmental groove. The dorsal cirri are purple, and the main stem of the gills is violet or brown. There is a purple stripe running down the middle of the caruncle. The median tentacle is about three times as long as the laterals and extends beyond the hinder end of the caruncle. In about the posterior half of the body the dorsal bristles show serrations at the end of the long limbs at their outer edge.

The present specimens are considerably smaller than those described by Horst. He gives a measurement of 22 mm. by 5 mm. without the bristles, whereas the largest of my examples measures only 9 mm. by 2 mm. for 21 chætigers. Moreover the spots on the back have faded to a pale orange and in one of the specimens have disappeared. Horst found serrated dorsal bristles in the 9th and following segments. In my specimens I can see none before about the 14th chætiger, but the condition of the bristles is very poor.

In 1924 (p. 72) I suggested that *C. conspicua*, *C. amphora*, *C. violacea* Horst, *C. parva* and *C. pulchella* Baird and *C. macleayi* Haswell were possibly colour-varieties of the well-known *Chlœia flava* (Pallas). There seems to be little else but a rather constant colour-pattern to distinguish one from another, and colour alone does not seem to be a good basis for specific distinction in the Polychæta.

Family Aphroditidæ.

Genus *Lœtmatonice* Kinberg.

Lœtmatonice producta Grube var. *benthaliana* McIntosh.

McIntosh, 1885, pl. viii, figs. 4, 5 ; pl. iv *a*, fig. 12 ; pl. v *a*, figs. 1, 2.
Fauvel, 1932, p. 10.

Occurrence :

St. 120, Zanzibar, 2926 m. (1).

St. 171, Central Arabian Sea, 3840–3872 m. (1).

Distribution.—Japan, Indian Ocean.

Remarks.—These specimens are in bad condition. One has 15 pairs of elytra and in the other they cannot be counted. There is no dorsal felting. Fauvel identifies the Japanese *Lœtmatonice* of Moore and Izuka, with which his Indian Ocean specimens agree, with McIntosh's var. *benthaliana*. Unfortunately McIntosh's types are too much damaged for purposes of comparison. The Antarctic *producta* is a much larger form, up to about 18 cm. in length, and has 18–20 pairs of elytra.

Genus *Aphrodite* L.

Aphrodite talpa Quatrefages.

Fauvel, 1925, p. 140, fig. 4 *a–l*, and 1932, p. 8. *Non* Ehlers, *nec* Benham, Augener, Fauvel (1917).

Occurrence :

St. 106, Zanzibar, 183–194 m. (1).

Distribution.—New Zealand, South Australia, Indian Ocean.

Remarks.—A small specimen measuring 20 mm. by 12 mm. The median tentacle is shorter than the head. The dorsal bristles are long, rather slender, smooth and with delicate curved tips. They are covered with mud and lie obliquely along the back, and with the naked eye cannot be picked out from the general coating of mud.

Genus *Hermione* Blainville.

Hermione hystrix (Savigny).

Fauvel, 1923, p. 35, fig. 11 *a–j* ; and 1932, p. 10.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Remarks.—Except that I cannot see any fine capillary bristles this specimen agrees well with *H. hystrix*, of which Fauvel has made Grube's *malleata* a synonym. The capillary bristles are presumably lost.

Genus *Aphrogenia* Kinberg.

Aphrogenia alba Kinberg.

Fauvel, 1932, p. 9, with synonymy.

Occurrence :

St. M.B. IIc, South Arabian Coast, 29 m. (1).

Distribution.—West Indies, Indian Ocean.

Remarks.—This agrees with Horst's *villosa*, which Fauvel identifies with Kinberg's *alba*, except in the colour pattern. The elytra are not white or grey-brown but reddish-brown and the nacreous markings are confined to the outer half of the elytra, where they form an irregular pattern varying from scale to scale. In Augener's *margaritacea* the nacreous pattern is more regular and more widely distributed over the surface of the scale. There are conspicuous black spots on the dorsal surface of the cirrigerous parapodia as described by Horst for his *A. nigropunctata*, which Augener regards as a synonym of *villosa*. The specimen measures 6 mm. by 3 mm. for about 24 chætigers.

Family Polynoidæ.

Genus *Harmothoë* Kinberg.

Harmothoë cornuta (Potts).

Lagisca cornuta Potts, 1910, p. 339, pl. 19, fig. 14 ; pl. 21, fig. 48.
Lagisca cornuta Horst, 1917, p. 94.

Occurrence :

St. 108, Zanzibar, 786 m. (1).

Distribution.—Solomon Island, Malay Archipelago, Zanzibar.

Remarks.—There are 36–38 chætigers. The elytra are sand-coloured, and the dorsum is dark brown with traces of a complicated pattern.

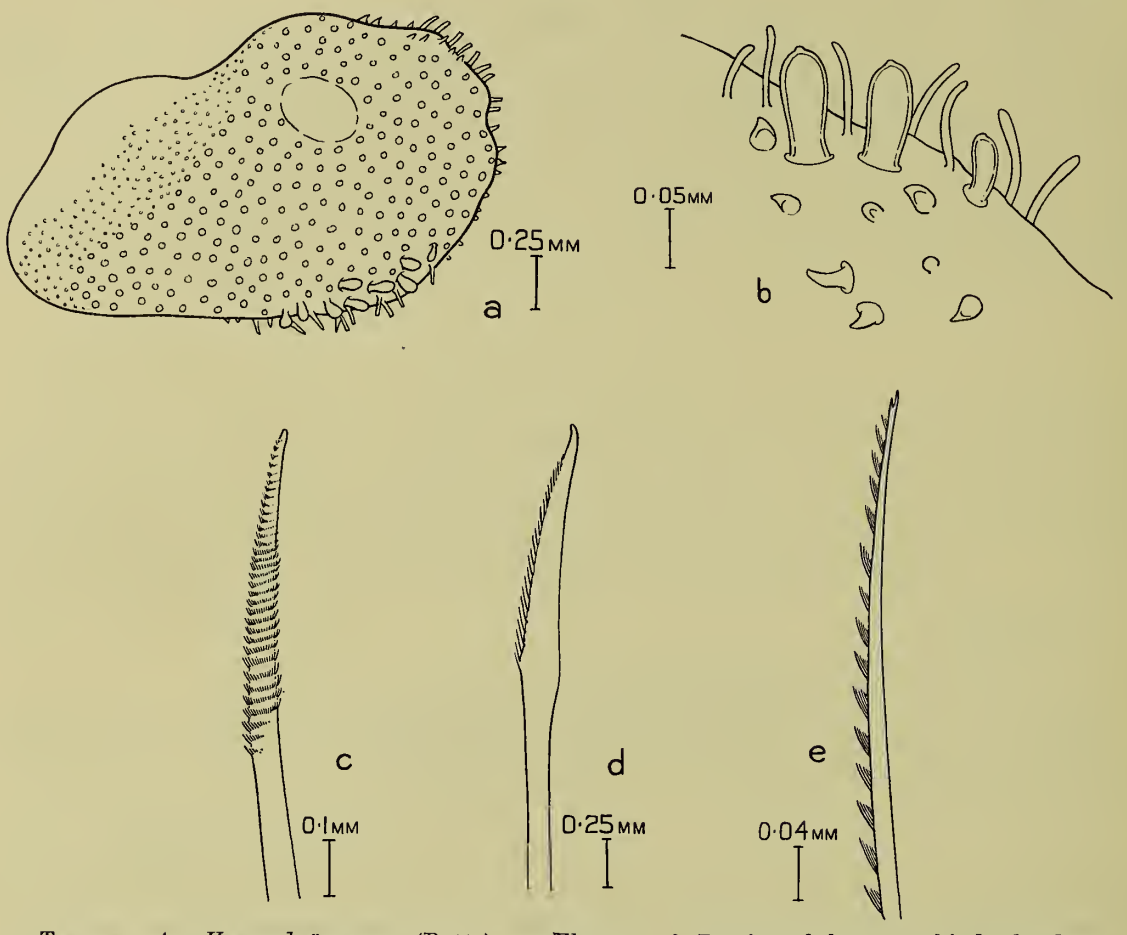
The head is deeply divided by a median groove and there are two pairs of large lateral eyes. The anterior and more lateral pair lie just above the cirrophores of the dorsal tentacular cirri. The posterior pair lie at the hinder corners of the head. The prostomial peaks are very marked, being pinched off into a pair of subulate papilliform processes. There is a large median tentaculophore. The median tentacle is not known. There is a pair of papillated lateral tentacles about as long as the head. They are very stout and cylindrical proximally and end in a filiform tip. Potts figures the palps as about twice as long as the head. They are smooth and tapering. The tentacular cirri are not known. The tentacular segment carries a few bristles.

The elytra (Text-fig. 4*a*) are sub-reniform. They are sparsely fringed at their hinder and outer borders, and carry (1) a large number of small curved spines, (2) a few large ovoid tubercles at the outer border (Text-fig. 4*b*).

In the feet there are a long tapering dorsal cirrus and a ventral cirrus extending to the end of the foot. Both pedal rami have large projecting sheathed acicula. There is a large bundle of strongly pectinated dorsal bristles (Text-fig. 4*c*). Potts says that they have a bifurcate apex. I believe the groove at the tip, which he figures, to be due to wear. Many of the dorsal bristles in the present specimen have the same appearance, but they are accompanied in the same foot by others that have the tip longer, more

pointed and entire. The ventral bristles are rather slender with long rows of frills. Those at the top and the bottom of the ventral ramus are unidentate (Text-fig. 4*d*), those in the middle bidentate (Text-fig. 4*e*). This is the condition in the type. Actually in the present specimen I cannot see any unidentate bristles in the upper part of the ventral ramus.

The present specimen measures 16 mm. by 2 mm. without the feet for 38 chætigers.



TEXT-FIG. 4.—*Harmothoë cornuta* (Potts). *a*, Elytron. *b*, Portion of elytron at hinder border. *c*, Dorsal bristle. *d*, Lower ventral bristle. *e*, Middle ventral bristle.

It is in very poor condition. The median tentacle, palps, tentacular and dorsal cirri are lost and only a few elytra in the anterior region are left.

The species has not a long attenuated hinder region, for there are less than 40 chætigers, and is therefore to be referred to *Harmothoë* rather than to *Lagisca*. Horst describes the elytra as being similar to those of *L. crosetensis* McIntosh. He failed to see the large ovoid tubercles. These may possibly be absent from the scales of the hinder region, as they are in the European *L. extenuata* (Grube). Actually the elytra in the present species are almost indistinguishable from those of Grube's species, to which the present species bears a great resemblance. *H. cornuta* is smaller with less than 40 chætigers, the head is divided by a deep median groove absent in *extenuata*, and the shape of the lateral tentacles is a little different. Otherwise there is little to separate the two species.

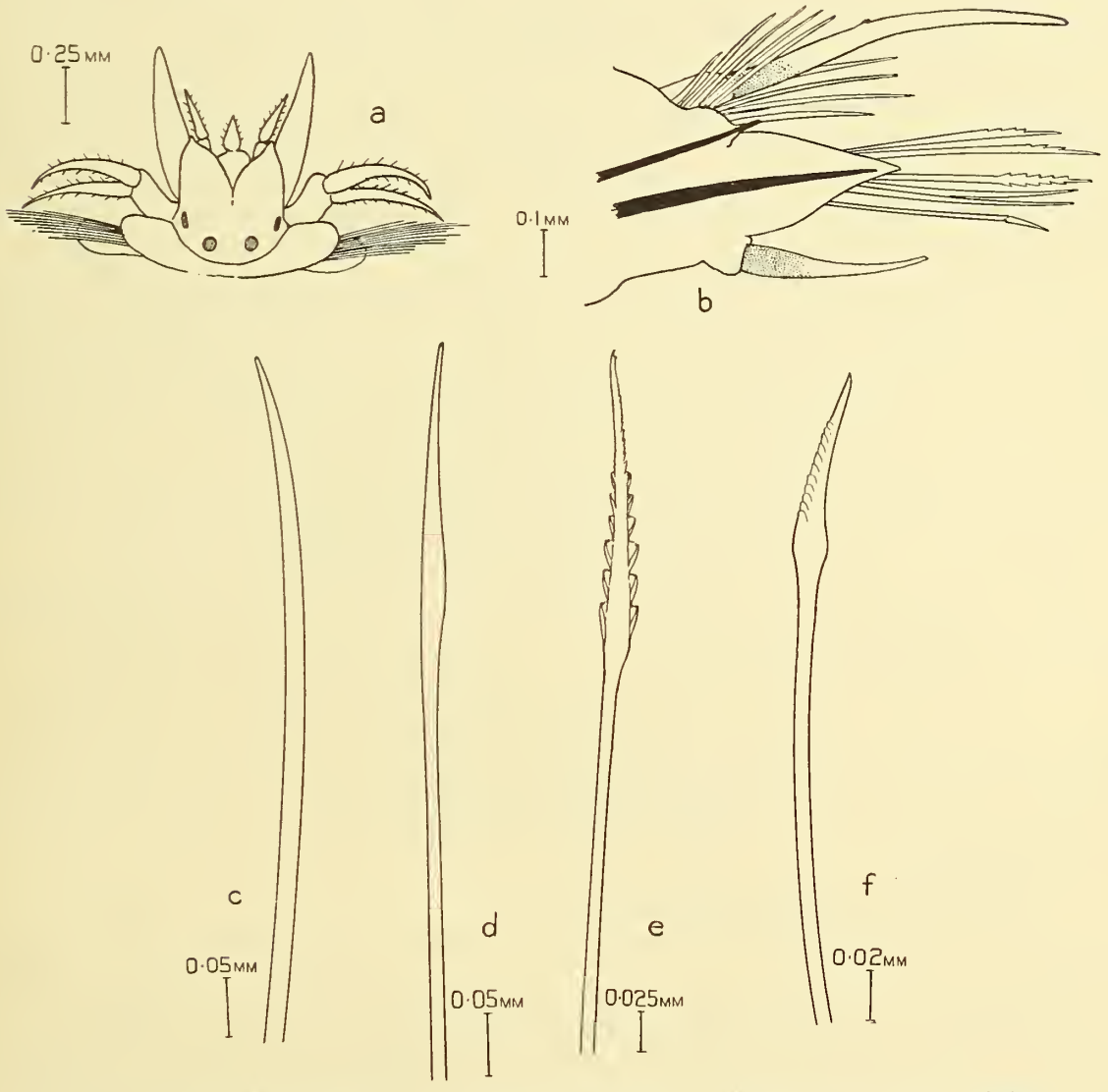
Harmothoë arabica n. sp.

Occurrence :

St. 139, Maldives, 57 m. (1).

Distribution.—Maldive area.

Description.—The specimen measures 7 mm. by 1 mm. without the feet for 36 chætigers. There is a little brown pigment on the head, brown mottling on the elytra,



Text-fig. 5.—*Harmothoë arabica*. *a*, Head from above. *b*, Middle foot. *c*, Dorsal bristle. *d*, Upper ventral bristle. *e*, Middle ventral bristle. *f*, Lower ventral bristle.

and the proximal half of the dorsal and ventral cirri is dark brown. Otherwise there is no colour. There is a typical harmothoid head (Text-fig. 5*a*) with well-developed peaks and two pairs of small eyes with a trapeziform arrangement. The anterior pair lies at the sides of the head just above the tentacular cirri and the posterior pair is more median and near the hinder border of the prostomium. There is a very short pyriform median

tentacle about half as long as the head. I suspect that it is incomplete. There is a pair of lateral tentacles, very stout proximally and about as long as the head. The subulate palps are slightly longer than this. The tentacular cirri are equal and about as long as the palps. The tentacles, tentacular and dorsal cirri are papillated. I see no papillæ on the ventral cirri.

Most of the elytra are lost, and the elytrophores are very difficult to count in the hinder region. As far as can be seen there are 16 pairs of elytra, the last pair very small and covering the pygidium. They are quite featureless, with neither tubercles nor papillæ. They are round, and have two patches of brown pigment.

As regards the feet (Text-fig. 5*b*), the ventral ramus is much more prominent than the dorsal. The notopod is supported by an aciculum with its end sheathed and projecting slightly. The notopodial bristles are numerous and a trifle stouter than the neuropodial. The ventral ramus sends out a long, pointed, triangular process. The dorsal cirri are very long, projecting beyond the ends of the neuropodial bristles. The ventral cirri are about half their length.

The dorsal bristles (Text-fig. 5*c*) are rather slender, slightly curved and quite smooth. Those at the bottom of the dorsal bundle are longer and straighter than the rest. The upper ventral bristles (Text-fig. 5*d*) are long, slender, lanceolate, unidentate and apparently quite smooth. There seem to be no transitional forms between these and the middle ventral bristles (Text-fig. 5*e*), which are also long and slender, but with well-developed rows of frills and a faintly bidentate tip. The lower ventral bristles are much shorter, faintly denticulated, with a wide subterminal enlargement and a tip that is either simple or faintly notched. There is a pair of long anal cirri, resembling the dorsal cirri.

Remarks.—I know no other *Harmothoë* with smooth dorsal and upper ventral bristles. The species has some affinity with *H. minuta* (Potts), which has serrated dorsal chætæ and a differently shaped head.

The specimen, despite its small size, is a ripe female full of eggs.

Harmothoë lunulata (Delle Chiaje).

Fauvel, 1923, p. 70, fig. 26 *a–o*.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—Atlantic, Mediterranean, Gulf of Panama, Galapagos, Arabian Coast.

Remarks.—A variable species. Length up to 35 mm. for 36–39 chætigers. Head bilobed without well-marked frontal peaks. Two pairs of eyes with a trapeziform arrangement, the anterior pair at the sides of the head. Lateral tentacles, short pyriform. Elytra 15 pairs, unfringed, smooth except for one or two small patches of minute carinulate tubercles in the anterior angle. They have brown markings, usually in the shape of a ring or a V. The cirri are papillated, the dorsal being also pigmented. The dorsal ramus of the foot is reduced, and carries up to about 30 rather short, slightly curved denticulated bristles with blunt tips. The ventral is well developed and prominent, and carries numerous long bidentate bristles with rows of frills. The second tooth is straight and delicate. Sometimes the uppermost and lowest bristles in the ventral ramus are unidentate.

The present specimen is very small, measuring only 8 mm. by 1 mm. for 34 chætigers. The elytra are ringed with brown pigment, the ring being wider on the inner side of the scale than the outer. I have compared it with some examples of this species from St. Vaast. It has the prostomial peaks rather less developed than the European specimens, the dorsal bristles are very decidedly coarser, and the frills on the ventral bristles more highly developed and conspicuous. Moreover the ventral bristles are relatively a little shorter. Otherwise I can find nothing to distinguish the two forms. The present specimen has all the ventral bristles bidentate. I have also compared it with the examples of *H. lunulata* var. *pacifica* mihi from the Galapagos. The Galapagos specimens are much more slender and elongate, and have longer and more slender tentacles and tentacular cirri. The prostomial peaks are more developed and the markings on the elytra different. Otherwise I cannot separate them. Actually the present specimen is closer to the St. Vaast examples than are those from the Galapagos. Fauvel (*loc. cit.*) has commented on the great variability of this species, especially as regards the dorsal bristles. As far as I know this species has never been recorded from the tropics except for my records from the Galapagos and Panama regions.

This specimen is said to have been found living deeply embedded in the cavity of a sponge.

Genus *Hololepidella* Willey.

Hololepidella commensalis Willey.

Willey, 1905, p. 251, pl. i, figs. 17–20.
Fauvel, 1932, p. 30.

Occurrence :

St. 152, Maldives, 609–915 m. (1).

Distribution.—Ceylon, Mergui, Maldive area.

Remarks.—One specimen in very bad condition. It measures 41 mm. by 3 mm. without the feet for about 95 chætigers. From its size and from the structure of the bristles, which agree with the accounts of Willey and Fauvel, it seems probable that it belongs to this species. It was obtained from the central cavity of a calcareous sponge.

Genus *Eunoë* Malmgren.

Eunoë pallida (Ehlers).

Fauvel, 1932, p. 17, with synonymy.

Occurrence :

St. 145e, Maldives, 494 m. (7).

Distribution.—Indian Ocean, Malay Archipelago, Maldive area.

Remarks.—These specimens are all in very bad condition. The measurement is about 20 mm. by 4 mm. without the feet for about 38 chætigers. The head is harmothoid in type. The ventral bristles are unidentate and agree with Ehlers' figures. The specimens are probably of this species. The fine, almost capillary bristles at the top of the ventral ramus seem to be characteristic.

Genus *Allmaniella* McIntosh.

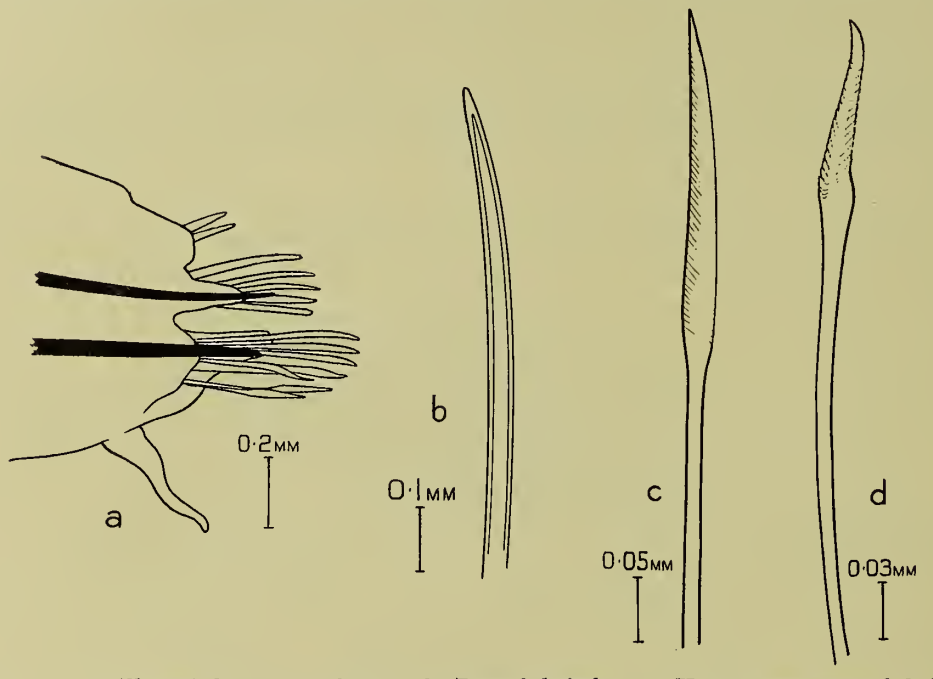
Allmaniella ? sp.

Occurrence :

St. 54, South Arabian Coast, 1046 m. (1).

St. 152, Maldives, 609–915 m. (7).

Remarks.—The condition of these specimens is such that I cannot confidently assign them to a genus. That from St. 54 is the best preserved, and this measures 20 mm. by 2 mm. without the feet for 49 chætigers. From the tapering of the body at the hinder end I judge it to be almost complete posteriorly. As far as can be seen, there are 15



Text-fig. 6.—*Allmaniella* sp. *a*, Foot. *b*, Dorsal bristle. *c*, Uppermost ventral bristle. *d*, Middle ventral bristle.

pairs of elytrophores and 18 chætigers behind the last pair. The heads are all distorted by what seems to have been a violent eversion of the proboscis, but they bear a general resemblance to Horst's (1917, pl. xviii, fig. 6) figure of that of *A. ptycholepis* (Grube). The head is broader than long, with a shallow median groove. There are two pairs of very large eyes, the anterior lying just above the insertion of the palps and the posterior a little more median. There is a small ceratophore of the median tentacle. Prostomial peaks are absent. The exact position of the lateral tentacles is very difficult to determine owing to the distortion of the head, but they appear to be subterminal rather than terminal. They are shorter than the head, very stout proximally, smooth and tapering. There is a pair of smooth, subulate palps, and of the tentacular cirri there remains a single ventral tentacular cirrus about half the length of the palps. The ventral cirrus of the first chætiger is a little shorter.

The elytra are all lost.

As regards the feet (Text-fig. 6*a*), the dorsal cirri are all lost, and the ventral are stout, smooth, and reach to the end of the ventral lobe. The dorsal ramus has a projecting

sheathed aciculum and a small bundle of about half a dozen bristles. The ventral ramus has the anterior lip of the chæta-sac prolonged into a triangular lappet. The dorsal bristles (Text-fig. 6*b*) are slightly stouter than the ventral, sword-like, quite smooth, and apparently grooved or excavated down the centre of the blade. The ventral bristles are numerous. At the top of the bundle there are a few, more slender than the rest (Text-fig. 6*c*), almost straight and with a very slight subterminal enlargement. They show only at high magnification very faint traces of denticulation in the form of slight grooving. The remainder of the ventral bristles (Text-fig. 6*d*) have a marked subterminal enlargement and a strongly curved tip. They are unidentate, and also show only very faint traces of denticulation. They resemble the ventral bristles of McIntosh's *Eunoë opalina*.

The number of chætigers (50 or more), the absence of prostomial peaks, the presence of only 15 pairs of elytrophores, the smooth dorsal bristles and the hooked, unidentate ventral bristles are a combination of characters which, as far as I know, is distinctive. They have certain affinities with *Allmaniella*, which has a rather similar head (but with terminally inserted lateral tentacles) and more or less smooth dorsal bristles. The shape of the feet is also similar, but *Allmaniella* has bidentate ventral bristles. They are perhaps referable to *Hermadion*. Horst's *Lagisca elytrophora* has somewhat similar bristles, but it presumably has prostomial peaks and there are no eyes. Izuka's *Harmothoë sinagawaensis* has rather similar ventral bristles, but it is a true *Harmothoë* with only 38 segments.

I suspect that these specimens represent a new species, but the material is inadequate for a proper diagnosis.

The specimens from St. 152 are said to have been found living in holes in the arms of a calcareous branching sponge.

Genus *Nectochæta* Marenzeller.

Nectochæta caroli Fauvel.

Fauvel, 1923, p. 91, fig. 35 *a–f*.
Monro, 1930, p. 46.

Occurrence :

St. 76B, Gulf of Oman, depth 600 m. (1).

Distribution.—Mediterranean, Atlantic, Gulf of Oman.

Remarks.—There are two fragments, an anterior and a posterior, probably parts of the same specimen. They are together composed of 26 chætigers and there are 12 pairs of elytrophores. The elytra are lost. The fragments correspond closely to Fauvel's description, except that the dorsal ramus is supported not only by a single aciculum, but also by two or three stout bristles embedded, like the aciculum, in the tissue of the foot.

Nectochæta grimaldii Marenzeller.

Fauvel, 1923, p. 90, fig. 34 *a–i*.

Occurrence :

St. 96, Central Arabian Sea, depth 400–645 m. (1).

Distribution.—Mediterranean, Atlantic, Arabian Sea.

Remarks.—This specimen measures 11 mm. by 1 mm. for 25 chætigers. All the elytra and dorsal cirri are lost. There are 12 pairs of elytrophores. The dorsal bristles

are nearly all broken off level with the foot, but I succeeded in finding one intact dorsal bristle. If, as Fauvel believes, this species is the young of the Indian Ocean *Lepidasthenia maculata* Potts, it seems probable that Chamberlin's *Harmopsides natans* from the Pacific, with its 18 pairs of elytrophores and its lack of bristles in the dorsal ramus, represents a later stage in the development of the same species.

Family Sigalionidæ.

Genus *Sigalion* Audouin and Milne-Edwards.

Sigalion mathildæ Audouin and Milne-Edwards.

Fauvel, 1923, p. 103, fig. 39 *a–l*.

Occurrence :

St. 80, South Arabian Coast, 16–22 m. (3).

Distribution.—Atlantic, Mediterranean, West Indies, Madagascar, South Arabian Coast.

Remarks.—Three fragmentary specimens in poor condition, the largest measuring 37 mm. by 3 mm. without the feet for 65 chætigers. I have compared them with some examples of this species from St. Vaast, and the differences are in my opinion too slight to warrant separation. The branches of the pinnate elytral papillæ are fewer, 8 to 10 on each side at about the 25th chætiger instead of 10 to 20, and are lanceolate rather than cylindrical. In fact the elytral papillæ resemble those of *S. squamatum* Delle Chiaje. Otherwise I can find nothing to distinguish the Indian Ocean from the European form.

I see only one pair of eyes. The slender dorsal and ventral tentacular cirri are about equal. The gill begins at the 4th chætiger. There are 3 ctenidia, the dorsal ramus has a single conical stylode, and the ventral also a small blunt stylode on its upper face. The dorsal bristles are finely denticulated capillaries with curved tips.

The upper bundle of ventral bristles contains about half a dozen simple bipectinate bristles and a number of multiarticulate compound bristles with claw-like tips. Some of these have the top of the shaft denticulated. The lower bundle of ventral bristles contains a few compound bristles with stout single-jointed blades and a great number of very slender multi-articulate bristles.

This species has been recorded from the West Indies by myself and from Madagascar by Fauvel (1919, p. 343). Augener (1927, p. 91) has attributed specimens from off New South Wales to Grube's *S. amboinensis* described from Amboina (Grube, 1877, p. 520), and also makes Horst's *S. bandaensis* a synonym of Grube's species. In Augener's opinion *S. amboinensis* is the Indo-Pacific representative of the European *S. mathildæ*. His description of the examples which he attributes to Grube's species seems, however, to present certain difficulties. Grube states that in his species there are no ctenidia ; Augener's specimens had ctenidia, and he regards Grube's affirmation of their absence as a mistake due to poor material or insufficient observation. Augener failed to find any single-jointed compound chætæ in the feet, but owing to the difficulty of the material he does not regard his failure as conclusive of their absence. Now *Sigalion ovigerum* Monro recorded from Port Jackson and from New Zealand is characterized by the absence of single-jointed compound bristles, and I strongly suspect that Augener had examples

of this species before him. That my species is identical with Grube's does not seem to me at all certain. It is only an assumption that ctenidia are really present in *amboinensis*, and the absence of single-jointed chætæ cannot be inferred from Grube's description. The question can only be settled by reference to Grube's type.

Augener makes Horst's *bandaensis* a synonym of his *amboinensis* Grube. Horst's species is described as having mostly single-jointed compound bristles in the *upper* neuropodial bundle and seems to me to be distinct.

Genus *Leanira* Kinberg.

Leanira vulturis Horst.

Horst, 1917, p. 118, pl. xxv, figs. 5–7.

Occurrence :

St. 191, Gulf of Aden. 274 m. (3).

Distribution.—Malay Archipelago, Gulf of Aden.

Remarks.—Three fragmentary specimens, the largest of which measures about 50 mm. by 2 mm. without the feet for 88 chætigers. They agree well with Horst's account except in the following particulars: Horst gives 2 pairs of eyes—an anterior and posterior; in these specimens an anterior pair only is faintly visible. Horst's specimens had tentacular ctenidia; in these they are absent. The median and lateral tentacles are very short. and consist of a ceratophore and 2 joints, a stout basal joint and a subulate terminal joint. The ventral tentacular cirrus is about half the size of the dorsal.

The elytra are transversely elongate, smooth and notched at the hinder edge of the external margin. The gill appears first at about the 15th chætiger. The feet carry very numerous stylodes and 3 ctenidia; 2 or 3 simple bipectinate bristles are present in the upper part of the neuropodia.

It is possible that these specimens represent a distinct form without posterior eyes and without tentacular ctenidia, but in view of the fact that in preserved material the aspect of the eyes is apt to be very variable and that tentacular ctenidia may easily be lost, I do not feel justified in making a separation. The species agrees with *L. japonica* in the possession of bipectinate chætæ in the neuropods, but differs in having short stumpy tentacles somewhat similar to those of *L. hystricis*.

Leanira japonica McIntosh.

Fauvel, 1932, p. 33, with synonymy.

Occurrence :

St. 137, Maldives, 46 m. (5).

St. 142B, Maldives, 37 m. (1).

Distribution.—Japan, Malay Archipelago, Indian Ocean, Maldive area.

Remarks.—These specimens are all incomplete. Both Izuka and Horst (under *L. sibogæ*) say that the hinder pair of eyes is the larger. In these specimens the kidney-shaped, anterior, subtentacular eyes are decidedly larger than the posterior pair. The median tentacle is as long as the dorsal tentacular cirrus. I can find no simple, bipectinate bristles in the neuropod. As Fauvel and others have shown, their presence is very inconstant.

Genus *Euthalanessa* Darboux.

Euthalanessa djiboutiensis (Gravier).

Fauvel, 1932, p. 32, with synonymy.

Occurrence :

St. 144, Maldives, 31 m. (1).

Distribution.—Red Sea, Ceylon, Mergui, Maldives.

Remarks.—A damaged anterior fragment without tentacles or palps. The ocular pigment is very conspicuous. There is a rust-coloured spot on each scale. Multi-articulate compound bristles are absent from the 4th to about the 12th chætiger. In my opinion this species is very doubtfully separable from McIntosh's *oculata*.

Family Polyodontidæ.

Genus *Polyodontes* Renier.

Polyodontes melanonotus (Grube).

Fauvel, 1932, p. 37, text-fig. 6, with synonymy.

Occurrence :

St. 72, Gulf of Oman, 73 m. (2).

Distribution.— West Indies, Malay Archipelago, Ceylon, Gulf of Oman.

Remarks.—Two anterior fragments in poor condition, the larger measuring 7 mm. in breadth without the feet. The ommatophores are clavate; there are small globular processes above the dorsal cirri and pseudo-penicillate bristles are present. The elytra are faintly areolated.

Polyodontes sp.

Occurrence :

St. 189, Gulf of Aden, 91 m. (1).

Remarks.—A single anterior fragment of a small panthalid. It measures 12 mm. by 2 mm. without the feet for 33 chætigers. It is puzzling because it agrees with *P. maxillosus* in having large cylindrical ommatophores and no pseudo-penicillate bristles, but differs in having small globular processes above the dorsal cirri. These processes are present in *P. melanonotus*, but it cannot be referred to that species because of the absence of pseudo-penicillate bristles. I suspect it of representing a young stage of one or the other of these two species, probably *melanonotus*.

Genus *Panthalis* Kinberg.

Panthalis ærstedi Kinberg.

Fauvel, 1932, p. 39, text-fig. 7, with synonymy.

Occurrence :

St. 106, Zanzibar, 183–194 m. (1).

Distribution.—Atlantic, Mediterranean, Pacific, Indian Ocean.

Remarks.—A single, anterior, damaged fragment having ommatophores and true penicillate chætæ. It probably belongs to this species. Usually the ommatophores

are colourless and there are no eye-spots on the prostomium. In this specimen the tops of the ommatophores are ringed with reddish-brown, and there is a pair of reddish eye-spots on the dorso-lateral surface of the head just behind the bases of the ommatophores.

Family Chrysopetalidæ.

Genus *Chrysopetalum* Ehlers.

Chrysopetalum occidentale H. P. Johnson.

H. P. Johnson, 1897, p. 161, pl. v, figs. 15 and 16 ; pl. vi, figs. 17–19.
Augener, 1913, p. 78.
Monro, 1933, p. 19.

Occurrence :

St. 45, South Arabian Coast, 38 m. (2).

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—California, Galapagos. South-west Australia, South Arabian Coast.

Remarks.—These specimens are in fragments. I have compared them with some examples from the Galapagos Islands, and in my opinion they are conspecific. Gravier's *C. ehlersi* is probably the same species, but both he and Gravely refer to the anterior pair of eyes as being in contact and ventrally situated. In these specimens the anterior pair of eyes is clearly visible from the dorsal surface and they do not touch each other.

Family Phyllodocidæ.

Genus *Phyllodoce* Savigny.

Phyllodoce madeirensis Langerhans.

Fauvel, 1932, p. 70, with synonymy.

Occurrence :

St. M.B. Id, Red Sea, 26 m. (1).

St. 27, Gulf of Aden, 37–91 m. (2).

St. 45, South Arabian Coast, 38 m. (3).

Distribution.—Atlantic, Mediterranean, Pacific, Indian Ocean.

Genus *Notophyllum* Oersted.

Notophyllum splendens (Schmarda).

Augener, 1913, p. 140, fig. 11, with synonymy.
Monro, 1934, p. 359.
Phyllodoce multicirris Grube, 1878, p. 100, pl. vi, fig. 4.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—South-west Australia, Philippines, China, South Arabian Coast.

Remarks.—A single specimen measuring 16 mm. by 1 mm. without the feet. Colour in spirit greenish yellow. Head small, oval, broader than long ; a long median tentacle almost twice as long as the head ; lateral tentacles spindle-shaped, about as long as the

head. One or sometimes two pairs of large dark eyes. In the present specimen there is only one pair, but Grube (*loc. cit.*) figures two pairs. There are 3 pairs of cirriform nuchal processes. These are well figured by Grube. Four pairs of tentacular cirri. First tentacular segment reduced dorsally. Dorsal cirri ear-shaped, ventral cirri ovate.

The nuchal organs in Marenzeller's *N. japonicum* have, as far as I know, never been described, and Izuka's *N. sagamianum* has nuchal organs with 4 pairs of processes. Otherwise it does not appear to be separable.

Genus *Eulalia* Oersted.

Eulalia tenax Grube.

Grube, 1878, p. 99, pl. vi, fig. 3.
Pterocirrus brevicornis Ehlers, 1904, p. 17, pl. ii, figs. 10–12.
Pterocirrus ceylonicus Michaelsen, 1892, p. 13, figs. 7, 8.
Eulalia magalhaensis Fauvel, 1919, p. 364, fig. iii; and 1932, p. 71; *nec* Kinberg.

Occurrence :

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Red Sea, Indian Ocean, Australia, New Zealand, South Arabian Coast.

Remarks.—I am inclined to agree with Fauvel in uniting *Pt. brevicornis* Ehlers with *Pt. ceylonicus* Michaelsen, but I have already affirmed (1933, p. 20) my inability to accept Fauvel's view that Kinberg's southern *magalhaensis* is the same as the tropical form. I have examined a number of antarctic specimens of Kinberg's species and I find no bristles in the second tentacular segment.

Genus *Lopadorhynchus* Grube.

Lopadorhynchus uncinatus Fauvel.

Fauvel, 1932, p. 75.

Occurrence :

St. 96, Central Arabian Sea, 400–645 m. (1).

Distribution.—Atlantic, Mediterranean, Maldives, Arabian Sea.

Remarks.—The specimen measures 12 mm. by 1 mm. without the feet for 28 chætigers.

Lopadorhynchus brevis Grube.

Fauvel, 1923, p. 184, fig. 69*k*.
Ehlers, 1913, p. 463.
Monro, 1930, p. 78.
Lopadorhynchus nans, Chamberlin, 1919, p. 116, pl. xvii, figs. 1–5.

Occurrence :

St. 186, Gulf of Aden, 250–0 m. (2).

Distribution.—Atlantic, Mediterranean, Pacific, Gulf of Aden.

Remarks.—These specimens measure about 12 mm. by 1 mm. without the feet for 25 chætigers. There is no colour. The head is cut off squarely in front and there are

2 pairs of tentacles, of which the upper is about twice the length of the lower. There are 2 pairs of tentacular cirri reaching back to the second chætiger, and a third rudimentary pair at the base of the second pair. There are 2 pairs of very indistinct eyes. The first 3 pairs of feet are only slightly shorter and stouter than those that follow. They have simple bristles only, and are without ventral cirri. The fourth foot has only paddle-shaped compound bristles above the aciculum and only simple bristles below it. A ventral cirrus is present. The remaining feet have a few simple bristles in addition to the compound chætæ.

As far as I know, Grube's species has never been thoroughly described, but Chamberlin claims that *L. brevis* has only a few simple bristles in the 4th foot instead of exclusively simple bristles in the ventral half. I am not inclined to attach much importance to this as a specific differential, for I suspect that the number of simple bristles in the 4th foot changes with the growth of the animal. Chamberlin has described a small *Lopadorhynchus* (*L. parvum* Chamberlin. 1919, p. 114) between 4 and 5 mm. in length which has only a few simple bristles in the 4th foot. I believe this to be a young example of Grube's *brevis*. The fact that no eyes were seen seems to me to have no importance, for the ocular pigment is clearly liable to disappear. Chamberlin describes for his *L. nans* postsetal processes on the first 3 feet which he regards as rudimentary ventral cirri. These I have not seen, but the state of preservation of the material is not good.

Lopadorhynchus brevis Grube var. *nuchalis* var. nov.

Occurrence :

St. 186, Gulf of Aden, 250–0 m. (1).

Distribution.—Gulf of Aden.

Description.—This specimen is indistinguishable from the examples of *L. brevis* with which it was taken except that (1) I can see no trace of eyes dorsally; (2) just behind the dorsal tentacles there is a pair of nuchal organs, each with 4 or 5 small finger-like processes; (3) on the lower surface of the head below the nuchal organs there is a pair of small patches of brown pigment, which I take to be ocular in character.

Remarks.—It is very possible that this specimen is simply a *brevis* with the nuchal organs everted, but I have not sufficient material to decide this. Chamberlin (1919, p. 119) has established a genus *Mastigethus* for a form *Mastigethus errans* very similar to the present specimen. He separates *Mastigethus* from *Lopadorhynchus* on the presence in the former of conspicuous, branching nuchal organs and of a pair of lateral processes arising from near the mouth of the proboscis. The present specimen has very similar nuchal organs but lacks the œsophageal processes, unless these be the lateral œsophageal glands generally present in *Lopadorhynchus*. These glands in *brevis* arise a little further back on the proboscis than indicated in Chamberlin's figure. Chamberlin's *errans* is distinctive in having no ventral cirrus on the 4th foot.

Claparède (1870, p. 465) for his *Hydrophanes* (*i. e. Lopadorhynchus*) *krohnii* describes eversible nuchal organs having the form of " boutons ciliés ", and it is probable that they are generally present in the genus. I therefore am of the opinion that *Mastigethus* should be placed in synonymy with *Lopadorhynchus*.

Family Alciopidæ.

Genus *Rhynchonerella* Costa.

Rhynchonerella fulgens Greeff.

Fauvel, 1923, p. 210, fig. 79 *a–d*.
Monro, 1930, p. 83, fig. 26.

Occurrence :

St. 61b, North Arabian Sea, 1000–0 m. (2).

St. 61c, North Arabian Sea, surface (1).

St. 96, Central Arabian Sea, 400–645 m. (1).

Distribution.—Atlantic, Mediterranean, South Sandwich Islands, Arabian Sea.

Remarks.—These are all fragments, which as far as they go correspond to Greeff's species. In the anterior region the stout acicular bristles are numerous, but in the middle and hinder regions are reduced to a single chæta. The foot has no cirriform process and the long capillary bristles are compound.

Genus *Vanadis* Claparède.

Vanadis formosa Claparède.

Fauvel, 1923, p. 205, fig. 77 *a–c*.
Monro, 1936, p. 116.

Occurrence :

St. 13d, South Arabian Sea, 500–0 m. (1).

Distribution.—Atlantic, Mediterranean, Pacific, Indian Ocean.

Remarks.—A single specimen broken into pieces. There are 3 pairs of tentacular cirri. Dark segmental glands are present in every segment. The specimen is a female.

Family Tomopteridæ.

Genus *Tomopteris* Eschscholtz.

Tomopteris (*Johnstonella*) *dunckeri* Rosa.

Rosa, 1908, p. 276, pl. xii, figs. 7–9.

Occurrence :

St. 7, Red Sea, 100–0 m. (3).

Distribution.—Ceylon, New Guinea, Red Sea.

Remarks.—The largest specimen, probably complete, has a tail about three-fourths as long as the body, and measures about 25 mm. by 1 mm. without the feet for 26 pairs of feet, of which about the first 18 are true body-segments. In the caudal region the feet are much reduced but continued to the end of the animal. There is no naked caudal cylinder. A second specimen has 19 pairs of feet and a small damaged tail in which the feet are all broken away, only a few shreds remaining. This measures 12 mm. in length for the body and 2 mm. for the tail. The third specimen has 19 body-segments and the tail is lost. It measures 12 mm. in length. There is a notch between the prostomial horns. A pair of black eyes is present. The scars marking the position of the anterior pair of cirri are clearly visible. The 2nd pair of cirri is about as long as the body without the tail. All the feet are provided with a sting in the ventral pinnules. In the

first 2 pairs of feet there are rosettes on the trunks near the point of division. Further back there are small rosettes in the pinnules lying below and above the dorsal and ventral trunks respectively, in the positions indicated by Rosa. There is a chromophil gland lying below the ventral trunk from the 3rd foot backwards. There are no hyaline glands. The gonad is confined to the dorsal ramus.

This species is immediately distinguished from *duccii* by the absence of hyaline glands. It has previously been taken off Ceylon and New Guinea. Rosa separates it from *T. aloysii-sabaudiæ* chiefly on the ground that the feet are continued to the end of the tail, whereas in *aloysii-sabaudiæ* the body ends in a naked cylinder. I share Fauvel's (1935, p. 298) opinion that in view of the extreme delicacy of the tail in the Tomopterids and the fragility of the feet this distinction is very doubtful. The question can be decided only by more and better-preserved material.

Tomopteris (*Johnstonella*) *duccii* Rosa.

Rosa, 1908, p. 273, pl. xii, figs. 1, 2.

Occurrence :

St. 131D, South Arabian Sea, 1500–0 m. (1).

Distribution.—Bay of Bengal, Arabian Sea.

Remarks.—A single specimen with the tail damaged. It measures 11 mm. by 1 mm. without the feet for 16 pairs of feet. It is incomplete posteriorly. There is no notch between the prostomial horns. A pair of conspicuous eyes is present. There is an anterior pair of cirri a little shorter than the prostomial horns, and the posterior pair is about two-thirds as long as the body. The first 2 feet have a large rosette on the trunk. Behind this the rosettes are situated just below and above the tips of the dorsal and ventral trunks respectively, as shown in Rosa's figure. According to Rosa all the feet have a pointed sting (*aculeo*) on the ventral surface of the pinnules, though little developed in the first 2 feet. In my specimen this sting appears to be absent from the first foot but is well developed in all the rest. Hyaline glands are present in all the feet just distal to the sting, and from the 5th foot there are also large chromophil glands lying just underneath the trunk of the ventral rami.

The gonad is confined to the dorsal ramus.

My specimen agrees on the whole well with Rosa's description and figures. The species is remarkable for the possession of all the three kinds of pedal glands, rosettes, hyaline and chromophil glands and an *aculeo*. It was originally taken in the Bay of Bengal.

St. 96 (depth 10 m.) yielded a much damaged specimen that very probably belongs to this species. It measures about 8 mm. in length with a naked tail of 1 mm. It is impossible to make an exact count of the parapodia. The feet are damaged, but as far as can be seen the number and arrangement of the glands are similar to those in the specimen from St. 131D.

Tomopteris cavallii Rosa

Fauvel, 1923, p. 222, fig. 84 *a*.

Occurrence :

St. 61B, North Arabian Sea, 1000–0 m. (2).

Distribution.—Atlantic, Indian Ocean, Arabian Sea.

Remarks.—Two very small specimens, the larger measuring 4 mm. in length for 12 pairs of feet. The only gland that I can find is a large chromophil gland lying below the ventral trunk, and I believe them to be young examples of this species. A small gonad is visible in the dorsal ramus. There is no sign of a first pair of chætigerous appendages.

Tomopteris planktonis (?) Apstein.

Fauvel, 1923, p. 224, fig. 84 *f*.

Occurrence :

St. 96, Central Arabian Sea, 10 m. (1).

Distribution.—Atlantic, Mediterranean, South Georgia, ? Arabian Sea.

Remarks.—One small damaged fragment, the feet of which show a large chromophil gland below the ventral trunk and a hyaline gland distal to it towards the edge of the pinnule.

Family Hesionidæ.

Genus *Hesione* Savigny.

Hesione intertexta Grube.

Monro, 1926, p. 311 ; and 1931, p. 9.

Occurrence :

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Philippines, Australia, Indian Ocean.

Remarks.—Usual size about 40 mm. by 5 mm. Body-colour in spirit varies from pale yellow to pale green with a very conspicuous brown dorsal striping. In the bristles the accessory tooth of the chætal guard approaches the apical tooth. Fauvel (1932, p. 60) regards this species as a synonym of the European *H. pantherina* Risso.

Family Syllidæ.

Genus *Syllis* Savigny.

Syllis variegata Grube.

Fauvel, 1923, p. 262, fig. 97 *h–n* ; and 1932, p. 76.

Occurrence :

St. 10, Red Sea, 55 m. (1).

St. 24, Gulf of Aden, 73–200 m. (1).

St. 44, South Arabian Coast, 0 m. (1).

St. 45, South Arabian Coast, 38 m. (3).

St. 53, South Arabian Coast, 13·5 m. (2).

Distribution.—Atlantic, Mediterranean, Pacific, Indian Ocean.

Remarks.—I have nothing to add to the numerous accounts of this widely distributed species. The specimens from St. 45 are rather puzzling. They are milk-white in colour, of considerable size, the largest fragment measuring 35 mm. in length, and with rather a low number of large articles to the dorsal cirri. In the anterior region the number of articles is 30–20 and in the middle and hinder regions 20–15. Moreover the bristles project very little beyond the pedal lobes. In this they resemble *S. inflata* Marenzeller. In other respects they agree with Gravier's Red Sea *S. compacta*, except that they are devoid of colour-markings.

Fauvel (1935, p. 300) has thrown *S. compacta* in with *variegata*, and although I am not satisfied that these specimens actually belong to *variegata*, I cannot find in them any good ground for separation.

Syllis gracilis Grube.

Fauvel, 1923, p. 259, fig. 96 *f–i* ; and 1932, p. 76.

Occurrence :

St. M.B. Ib, Red Sea, 29 m. (1).

St. 45, South Arabian Coast, 38 m. (1).

St. 112, Zanzibar, 113 m. (1).

St. 157, Maldives, 229 m. (4).

Distribution.—Atlantic, Mediterranean, Pacific, Indian Ocean.

Remarks.—This species is easily recognizable by the large crutch-like simple chætæ in the middle and hinder regions.

Syllis krohnii Ehlers.

Fauvel, 1923, p. 259, fig. 96 *a–e* ; and 1930, p. 13.

Occurrence :

St. M.B. Ib. Red Sea, 29 m. (1).

St. 10, Red Sea, 55 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Red Sea.

Remarks.—The specimen from St. M.B. Ib, shows the usual transverse banding in the anterior region ; in that from St. 10 it is not visible. The articles of the cirri are numerous, short and crowded. The bristles are unidentate except in the anterior region, where a small accessory tooth is usually present.

Syllis brachychæta Schmarda.

Augener, 1918, p. 247, pl. iv, figs. 83–85 ; pl. v, fig. 98, text-fig. xx.
Syllis closterobranchia Schmarda, Fauvel, 1932, p. 77.

Occurrence :

St. 45, South Arabian Coast, 38 m. (2).

St. 53, South Arabian Coast, 13·5 m. (4).

Distribution.—Indian Ocean, South Africa, Australia, New Zealand, South Atlantic.

Remarks.—I am inclined provisionally to accept Augener's attempted unravelling of the complex synonymy of this species. Fauvel gives as a specific character that the bristles in the middle region of the body are unidentate. I am not convinced that this is so in all specimens, and I believe that in some a small second tooth, often very difficult to see, persists throughout.

Syllis curticirris n. sp.

Occurrence :

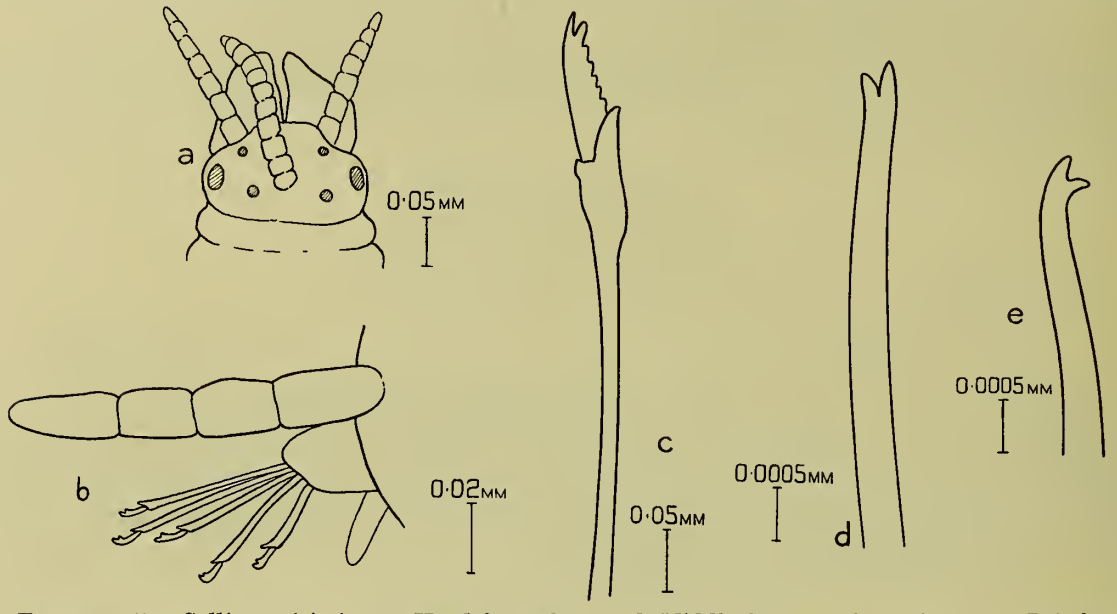
St. 112, Zanzibar, 113 m. (1).

Distribution.—Zanzibar.

Description.—A single ripe female measuring 6 mm. in length for about 60 chætigers. The body is slender, thread-like, and there is no colour. The palps are clearly divided (Text-fig. 7*a*). There are 2 pairs of eyes in a semicircle. Also an accessory pair of small

anterior eyes. The tentacles are about equal with about 10 articles. All the tentacular cirri are lost except one and this has 3 articles. I believe it to be incomplete. For the first few chætigers behind the head the dorsal cirri have about 10 articles. Behind this and throughout the rest of the body they are exceedingly short, having 4 and 3 articles alternately. Foot (Text-fig. 7*b*) conical. Ventral cirrus short, conical; shows no change throughout the body. Pharyngeal tooth not quite terminal. I have not been able to see the pharyngeal papillæ. Pharynx extends to 6th chætiger and proventriculus to 11th.

The feet carry about 6 bristles. These all have slender shafts and clearly bidentate



Text-fig. 7.—*Syllis curticirris*. *a*, Head from above. *b*, Middle foot seen from above. *c*, Bristle. *d*, Simple dorsal hook from hinder region. *e*, Simple ventral hook from hinder region.

end-pieces (Text-fig. 7*c*). They vary very little throughout the body. In the hinder region there is a large dorsal simple bidentate hook (Text-fig. 7*d*) and a smaller ventral one (Text-fig. 7*e*).

Remarks.—I know no other *Syllis* with dorsal cirri so short. It appears to be related to the European *S. brevipennis* Grube, but differs in being unpapillated and in having the dorsal cirri slender instead of thick and fusiform.

Syllis sp. juv.

Occurrence :

St. M.B. Ib, Red Sea, 29 m. (1).
St. M.B. Id, Red Sea, 26 m. (1).
St. 27, Gulf of Aden, 37–91 m. (1).
St. 53, South Arabian Coast, 13·5 m. (1).

Remarks.—These are all small Syllids about 5 mm. in length. I can find nothing distinctive about them. The head, pharynx and tooth are typical of the genus, the dorsal cirri have about 15–20 articles and the bristles are bidentate. They may well be young examples of *S. variegata*.

Syllis (*Haplosyllis*) *spongicola* Grube.

Fauvel, 1923, p. 257, fig. 95 *a–d* ; and 1932, p. 76.

Occurrence :

St. M.B. Id, Red Sea, 26 m. (5).

St. 10, Red Sea, 55 m. (1).

St. 24, Gulf of Aden, 73–200 m. (1).

St. 27, Gulf of Aden, 37–91 m. (3).

St. 53, South Arabian Coast, 13·5 m., from fenestra of a Polyzoan *Retepora* (1).

St. 112, Zanzibar, 113 m. (2).

Distribution.—Atlantic, Mediterranean. Pacific, Indian Ocean.

Remarks.—The specimens from St. M.B. Id and St. 112 show certain unusual features. In all the body is massive anteriorly and very much arched. An average measurement is about 20 mm. in length. The dorsal cirri in the anterior region are very long, the longer cirri having about 40 articles. Otherwise in the structure of the feet, the bristles, the pharynx, etc., I can find no ground for separation. Fauvel (1933, p. 50) has described a *Syllis* (*Haplosyllis*) *depressa* Augener var. *dollfusi* from the Red Sea, which is also very highly arched dorsally but the bristles are quite different.

Syllis (*Ehlersia*) *cornuta* Rathke.

Fauvel, 1923, p. 267, fig. 100 *g–i* ; and 1930, p. 14.

Occurrence :

St. 53, South Arabian Coast, 13·5 m. (1 juv.).

St. 105B, Zanzibar, 238–293 m. (1).

St. 106, Zanzibar, 183–194 m. (1).

Distribution.—Atlantic, Mediterranean, Persian Gulf, Arabian Coast, Zanzibar.

Remarks.—These specimens show nothing noteworthy.

Genus *Trypanosyllis* Claparède.

Trypanosyllis zebra Grube.

Fauvel, 1923, p. 269, fig. 101 *a–e* ; and 1932, p. 78.

Occurrence :

St. M.B. Id, Red Sea, 29 m. (1).

St. M.B. Ic, Red Sea, 26 m. (1).

St. 53, South Arabian Coast, 13·5 m. (2).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Remarks.—The bristles are clearly bidentate.

Genus *Parasphærosyllis* gen. nov.

Parasphærosyllis indica gen. et sp. nov.

Occurrence :

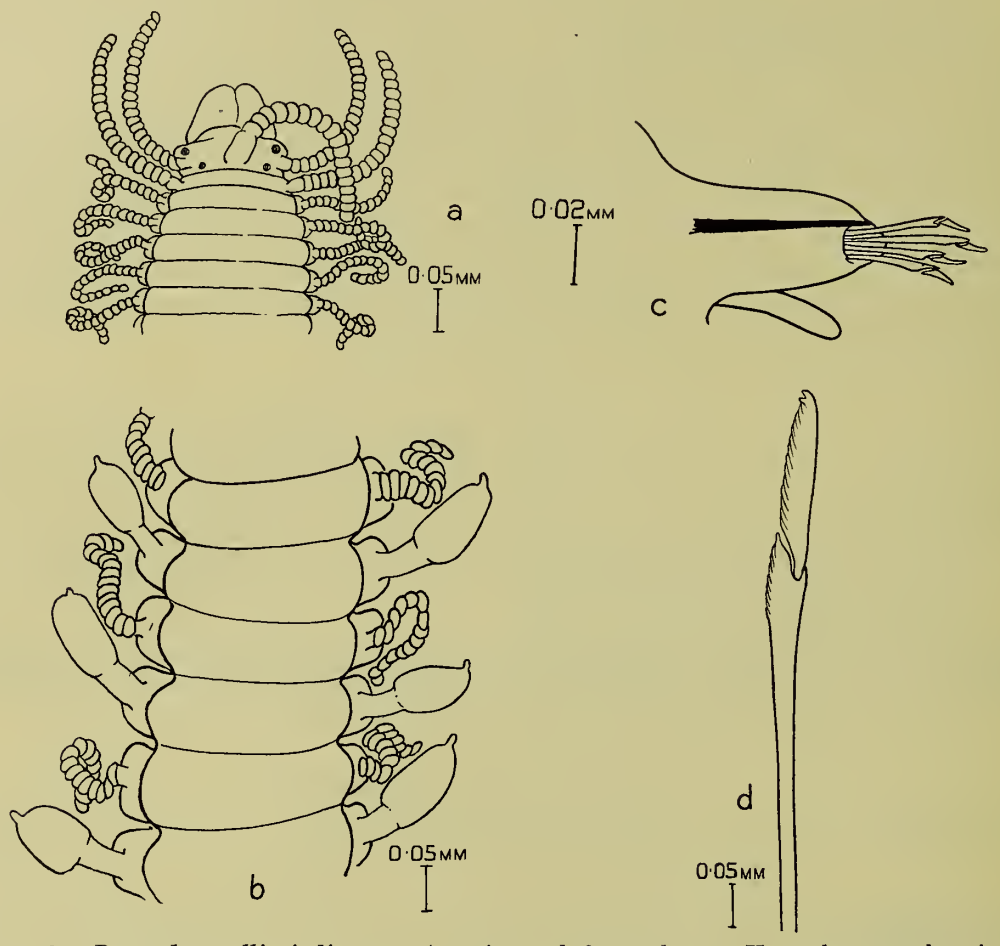
St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Arabian Coast.

Description.—On the present inadequate material only a provisional account can

be given, and I feel that there is nothing to be gained by attempting a generic definition. The single specimen is a Syllid in the chain phase and has one stolon. The total measurement is 7 mm. in length, of which 2 mm. is occupied by the stolon. The breadth is about 0·5 mm. The total number of chætigers is 85, of which 20 belong to the stolon.

The body is slender and thread-like. There is no colour. The head (Text-fig. 8*a*) is rather broader than long with two pairs of eyes arranged in a trapeze. The palps are somewhat pointed and fused except at the extreme tip. The tentacles, tentacular cirri



TEXT-FIG. 8.—*Parasphærosyllis indica*. *a*, Anterior end from above. Ventral tentacular cirri not seen. *b*, Middle region from above. *c*, Middle foot from above; dorsal cirrus not shown. *d*, Bristle.

and the dorsal cirri of the first 15 chætigers are clearly moniliform and tightly coiled. The tentacles are about twice as long as the head and have about 20 articles. There is a dorsal pair of tentacular cirri which appear to be about the same size as the tentacles, but owing to the tight coiling their size is very difficult to estimate. There may be a pair of ventral tentacular cirri, but of this I am not sure. The pharynx is twisted and reaches back to the 9th chætiger; the proventriculus to the 16th. The ventriculus takes a turn forward through two segments before running backwards. There is a small triangular structure a little way behind the mouth of the pharynx, which I take to be a pharyngeal tooth, but I cannot see it clearly.

The first 15 chætigers have long, slender moniliform dorsal cirri with about 15 articles. At the 16th chætiger the dorsal cirrus is a large bulbous fusiform structure with a small terminal knob. This organ shows no trace of articulation, and the main bulbous stem has a reticular appearance under the microscope. From the 16th chætiger to the end of the stock these bulbous, fusiform cirri occur alternately with the slender moniliform cirri (Text-fig. 8*b*). They are also continued on to the stolon, but I am not sure that here they have an alternate arrangement. The stolon is somewhat damaged and most of the cirri are lost, and I can find bulbous cirri only on the 1st, 4th and 10th chætigers. On a number of the remaining segments slender, moniliform cirri are present.

The feet (Text-fig. 8*c*) are conical and there is a small subulate ventral cirrus. Each foot carries about half a dozen bristles (Text-fig. 8*d*), which are slender and have straight end-pieces faintly bidentate at the tip. The form of the bristles does not appear to alter throughout the body.

The beginning of the stolon is marked by 2 pairs of eyes, each pair being situated at the outer edge of the dorsal surface of the segment. The body ends in a pair of moniliform anal cirri.

Remarks.—The fusion of the palps places this species among the *Exogoninæ*, and the bulbous cirri would seem to have affinities with those of *Sphærosyllis*, but I know no Syllid which has this curious alternation of bulbous and slender moniliform dorsal cirri.

Family Nereidæ.

Genus *Nereis* Cuvier.

Nereis jacksoni Kinberg.

Fauvel, 1932, p. 97, with synonymy.

Occurrence :

St. M.B. Ib, Red Sea, 29 m. (3).

St. M.B. Id, Red Sea, 26 m. (17).

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Pacific, Indian Ocean, Australia, New Zealand.

Remarks.—These are all very small specimens, the larger measuring between 20 and 25 mm. by 1 mm. for 60–70 chætigers. They are recognizable by the presence in the middle and posterior feet of large bi- or tridentate homogomph falcigers. With Augener I am unable in the majority of examples to find paragnaths on the oral ring.

Nereis zonata Malmgren var. *persica* Fauvel.

Fauvel, 1932, p. 96.

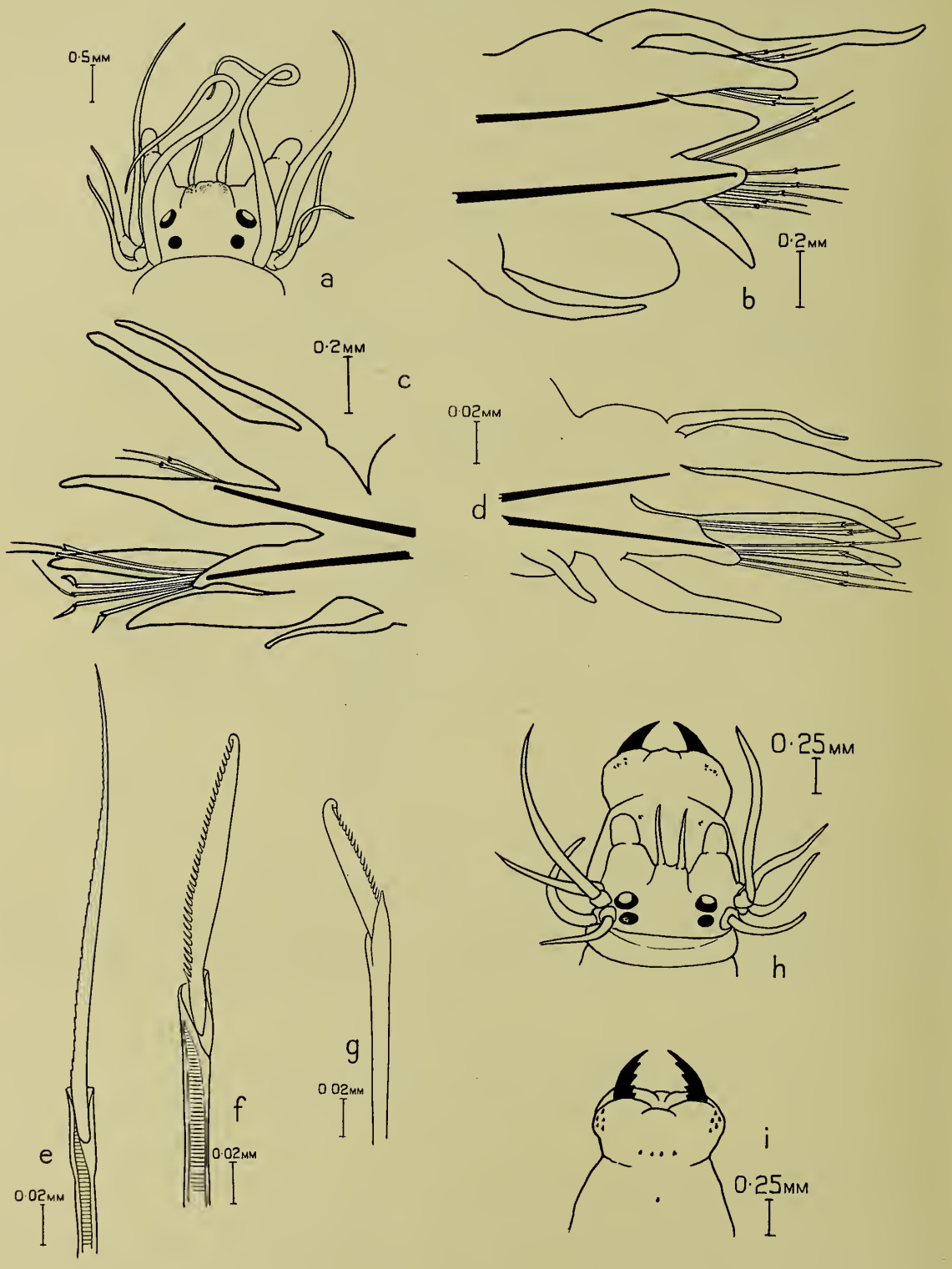
Occurrence :

St. 45, South Arabian Coast, 38 m. (2).

Distribution.—Red Sea, Persian Gulf, India, Arabian Coast.

Remarks.—One of these specimens has the proboscis everted and shows the typical arrangement of paragnaths. There are both bi- and tridentate homogomph falcigers in the hinder region.

TEXT-FIG. 9.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0·25MM
h
i
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Nereis longilingulis n. sp.

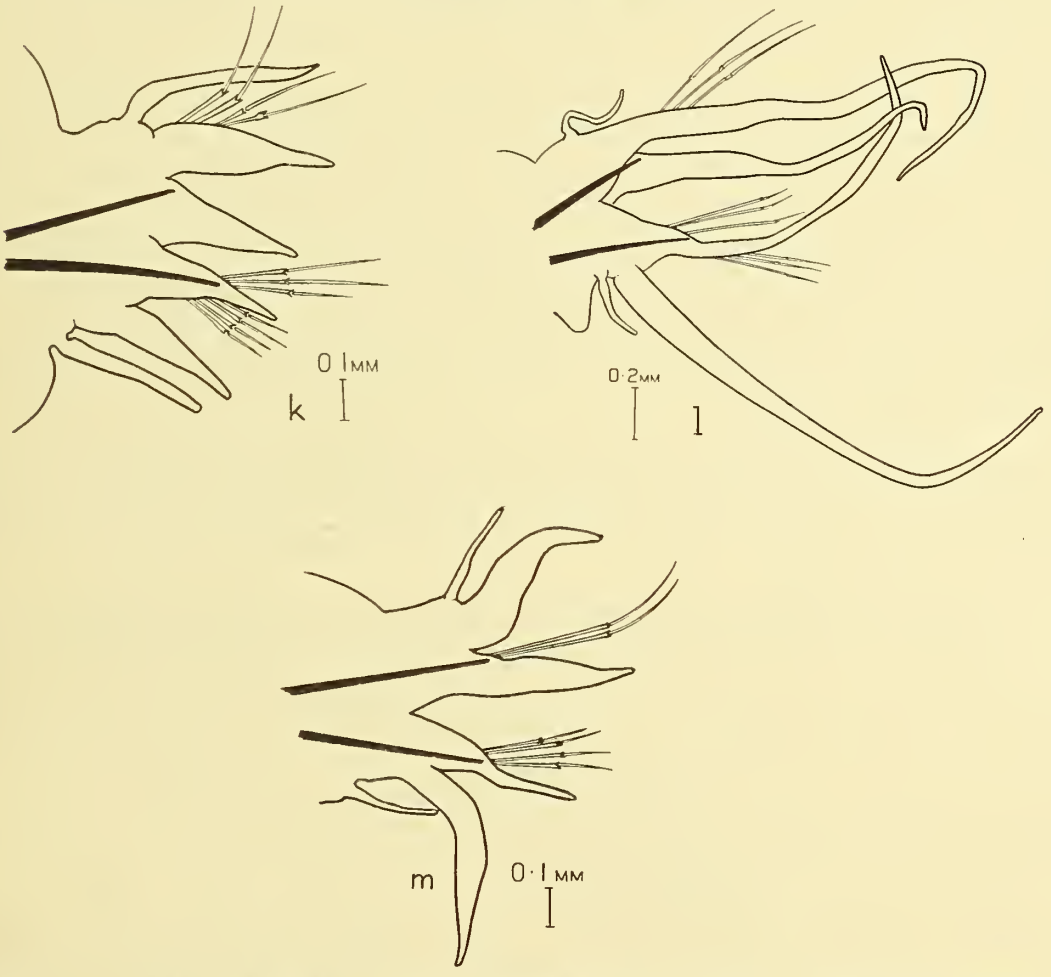
Occurrence :

St. 89, North Arabian Sea, 135–183 m. (8).

Distribution.—Arabian Sea.

Description.—These specimens fall into two distinct groups separable superficially on size, and although I believe that the smaller specimens represent a stage in the growth

Text-fig. 9—*continued.*



Text-fig. 9.—*Nereis longilingulis*. *a*, Head of larger form from above. *b*, 5th foot of larger form. *c*, 20th foot of larger form. *d*, 40th foot of larger form. *e*, Dorsal homogomph spiniger from larger form. *f*, Ventral hemigomph falciger from middle region of larger form. *g*, Ventral heterogomph falciger from hinder region of larger form. *h*, Head of smaller form from above. *i*, Ventral view of proboscis of smaller form. *k*, 5th foot of smaller form. *l*, 20th foot of smaller form. *m*, 70th foot of smaller form.

of the larger, the differences are so marked that I propose to describe the two groups separately.

In the group containing the larger specimens there is one complete example measuring about 45 mm. by 2 mm. at the widest part for 77 chætigers. The specimen is very much coiled so that an exact measurement is impracticable. The body is much tapered behind

and in spirit there are no colour-markings. The head (Text-fig. 9*a*) is longer than broad, not incised between the tentacles. The palps have stout palpophores and short clavate styles. Palps and tentacles about equal in length. There are 2 pairs of eyes with lenses. The longest tentacular cirrus reaches back to the 10th chætiger. The buccal segment is rather long. One specimen has the proboscis everted. The jaws are pale, and have the inner edges finely serrated. I can find no trace of paragnaths at all.

The feet vary according to their position in the body. At the 5th foot (Text-fig. 9*b*) there is a slender dorsal cirrus about twice as long as the narrow digitiform upper dorsal languet. The latter extends as far as the articulation of the bristles. There is a lower dorsal languet a little shorter and stouter than the upper. In the ventral ramus the anterior lip of the chæta-sac supported by a single black aciculum forms a conical process about as long as the lower dorsal languet, and the base of the hinder lip of the chæta-sac is carried out into a long, digitiform process similar to the upper dorsal languet. There is a stout, conical ventral languet and a slender ventral cirrus about as long as this. At the 10th foot there is little change except that the languets are relatively more slender. At the 20th foot (Text-fig. 9*c*) the upper dorsal languet is about as long as the dorsal cirrus and all the languets are much longer, thinner and more flagelliform. This does not apply to the anterior lip of the chæta-sac containing the aciculum, which shows no increase. There is at the same time a slight but steady decrease in length of the dorsal cirrus from before backwards.

At the 40th foot (Text-fig. 9*d*) the languets are still more elongate, and the dorsal cirrus is only about two-thirds of the length of the upper dorsal languet. At the 70th foot the languets are still very slender but considerably shorter, and the dorsal cirrus is about equal to the upper dorsal languet. The two rami are each supported by a single black aciculum throughout.

As regards the bristles, the dorsal ramus has only homogomph spinigers (Text-fig. 9*e*). The upper ventral bundle consists of homogomph spinigers and homogomph or hemigomph falcigers; the lower ventral bundle has homogomph spinigers and homogomph and hemigomph falcigers. These last (Text-fig 9*f*) have very long and slender ciliated blades and curved tips attached to the blades by short ligaments. In the hinder region the lower ventral bundle has a few rather larger heterogomph falcigers with relatively short blades (Text-fig. 9*g*). There is a short conical anus and a pair of rather small anal cirri, very possibly broken off short.

In the second group of specimens there is one complete example. It measures about 30 mm. by 1 mm. at the widest part for 80 chætigers. The body is dorsally banded with brown in the anterior region. The head (Text-fig. 9*h*) is rather long and narrow, not incised between the tentacles. There are 2 pairs of eyes without lenses arranged in a rectangle. The tentacles equal the palps in length. The longest tentacular cirri reach back to the 15th chætiger. The buccal segment equals in length the first 2 chætigers. On the proboscis (Text-fig. 9*i*) the arrangement of the paragnaths is as follows: I, *nil*; II, small crescentic patches; III, a transverse row of 4 relatively large paragnaths; IV, small crescentic patches; V, *nil*; VI, a single small paragnath; VII, a single small paragnath; VIII, *nil*. Only one specimen has the proboscis everted, but in all the presence of paragnaths can be seen by dissection.

As in the larger specimens, the feet vary according to their position in the body. At the 5th foot (Text-fig. 9*k*) there is a dorsal cirrus about equal in length to the upper dorsal

languet. This is slender and more or less digitiform. The lower ventral languet is a little broader and shorter than the upper. In the ventral ramus the lip of the chæta-sac is prolonged into a slender process similar to the dorsal languets. There is a ventral languet also similar to the rest, and a long slender ventral cirrus a little shorter than the ventral languet. There is a rapid decrease in length of the dorsal cirrus from before backwards. By the 10th foot the languets have greatly increased in length, and the upper dorsal languet is more than twice as long as the dorsal cirrus. By the 20th chætiger (Text-fig. 9*l*) the languets are completely flagelliform and have reached an extraordinary length. The dorsal cirrus has much decreased. By the 40th foot there is little change. At the 70th chætiger (Text-fig. 9*m*) all the languets are slender but very much reduced in length.

The bristles in this group of specimens appear to be similar to those in the other. The dorsal ramus has homogomph spinigers only, and the ventral ramus has homogomph spinigers and homogomph, hemigomph, and in the hinder region heterogomph falcigers. The only complete specimen has a pair of long anal cirri.

Remarks.—Although these two groups of specimens, both taken in the same haul, show certain differences in the relative length of cirrus and languet and of the various languets, the fundamental form of the feet is the same. Moreover the form is very unusual. I therefore have no explanation to offer for the fact that no trace of paragnaths can be found in any of the four larger specimens and their presence easily detected in the smaller. That in the larger specimens they are simply lost I do not believe. It is possible that when the animal reaches a certain size the paragnaths are shed, but this is mere speculation. If confirmed, it would mean that the fully grown form would be attributable to *Leptonereis* and the young form to *Nereis*.

In the extreme elongation of the languets the species has certain affinities with *Nereis* (*Ceratonereis*) *flagellipes* Fauvel, but differs in a number of characters, notably in having one and not two flagelliform processes arising from the ventral chæta-sac and in having differently shaped blades to the falcigers.

Genus *Platynereis* Kinberg.

Platynereis pulchella Gravier.

Gravier, 1900, pl. xii, figs. 55, 56; and 1901, p. 202, text-figs. 210–213.
Platynereis dumerilii Audouin and Milne-Edwards, var. *pulchella*, Fauvel, 1911, p. 402, pl. xx, figs. 30–32.
Platynereis pestai Holly, 1935, p. 27, pl. i, figs. *j*, *k*, and text-figs. 13–15.
Platynereis pulchella Monro, 1936A, p. 380, figs. 1–3.

Occurrence :

St. M.B. IIa, South Arabian Coast, 11 m. (7 atocous and 1 semi-epitocous).
St. Extra, East side of Ras Madraka, South Arabian Coast, shore collection (4 atocous).
St. 18, Gulf of Aden, 900–0 m. (1 atocous).
St. 22, Central Arabian Sea, from Sargasso weed (2 atocous).
St. 25, Gulf of Aden, from Sargasso weed (7 atocous and 1 epitocous).
St. 27, Gulf of Aden, 37–91 m. (1 atocous).
St. 41, South Arabian Coast, surface (2 atocous).
St. 44, South Arabian Coast, surface (14 atocous).

Distribution.—Red Sea, Persian Gulf, Gulf of Aden, Arabian Coast, Hawaii ?.

Remarks.—There are one epitocous male, one semi-epitocous and a number of atocous specimens. The average size of the atocous examples is about 20 mm. by 2 mm. for about 70 chætigers. The head (Text-fig. 10*a*) is broader than long and the palps slender. There are 2 pairs of eyes. The tentacles are as long as the palps. The hindmost tentacular cirrus reaches back to the 12th chætiger. The buccal segment is long and forms a kind of neck, where the body narrows in front. The proboscis is partly everted in one specimen only, the semi-epitocous male from St. M.B. II. The arrangement of the paragnaths is as follows : I and II, *nil* ; III, a small, rounded patch ; IV, curved, pectinate clusters ; V, *nil* ; VI, an elongate pectinate cluster ; VII and VIII, about 5 small patches of pectinæ.

The feet (Text-fig. 10*b*) consist of the usual dorsal and ventral rami. The dorsal ramus has a cirrus and 2 narrow, equal, conical languets ; the dorsal cirrus is rather more than twice as long as the upper dorsal languet. The ventral ramus has a prominent, 2-lipped chætal lobe, a ventral languet similar to the dorsal and a slender, ventral cirrus slightly shorter than the ventral languet. Both rami are supported by large, colourless acicula. The dorsal ramus carries a number of slender homogomph spinigers, and below these 1 to 4 homogomph falcigers (Text-fig. 10*c*) with downwardly curved tips, and conspicuous terminal ligaments having their basal attachment as far down as the lip of the articular cup. In many specimens these dorsal homogomph falcigers are present in the most anterior segments and in all they appear before the 20th chætiger. They are present in the anterior unmodified region of the male heteronereid from St. 25. The upper ventral ramus carries heterogomph spinigers and heterogomph falcigers ; the lower ventral ramus also carries heterogomph spinigers and heterogomph falcigers (Text-fig. 10*d*). In the hinder region there is no change in the structure of the feet, but I see no spinigers in the lower ventral bundle. The body ends in a pair of long pygidial cirri.

The male heteronereid measures about 10 mm. by 1 mm. for about 75 chætigers. It bears a strong resemblance to *Platynereis polyscalma* Chamberlin. In both the head turns over on to the ventral surface. Both have the first 14 chætigers unmodified ; the arrangement of the pedal languets in both the unmodified and modified region is similar in both species ; both have fringed swimming-bristles and simple bristles with ribbed blades in the hinder region. There are, however, a number of clear points in which they differ, for I have compared the specimen with two examples of *P. polyscalma* from Indo-china very kindly lent me by Prof. Fauvel. As far as can be seen from the small quantity of material, the body in *polyscalma* is more slender and elongate than in *pulchella*. The head (Text-fig. 10*e* and *f*) in *pulchella* is very little longer than broad and therefore relatively much shorter than in *polyscalma*, and this is due to the comparatively slight development of the preocular snout. The eyes have a similar position in both species,

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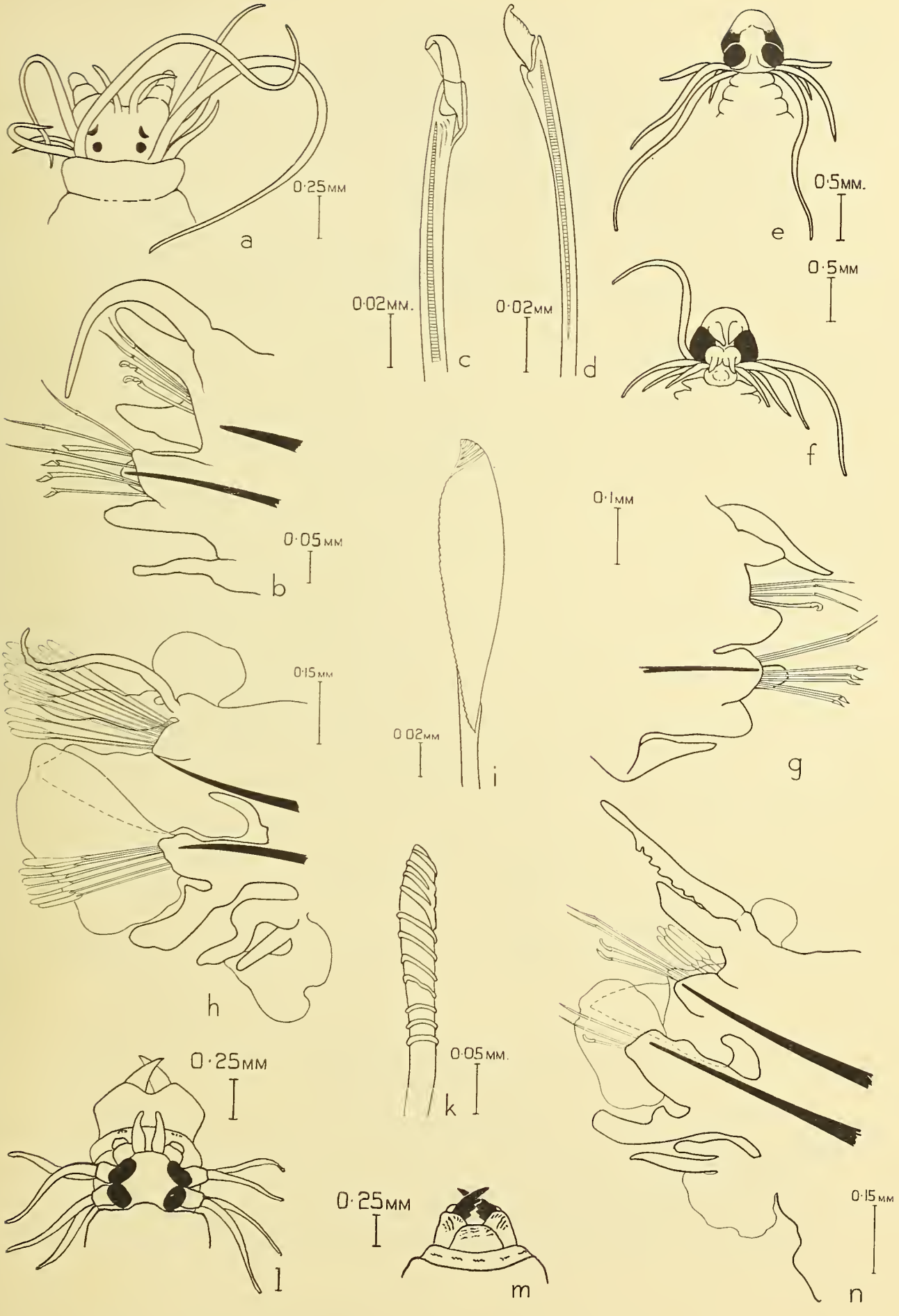
Text-fig. 10.—*Platynereis pulchella* Gravier. *a*, Head from above (atocous). *b*, Middle foot (atocous). *c*, Dorsal homogomph falciger from anterior region (atocous). *d*, Ventral heterogomph falciger from middle region (atocous). *e*, Dorsal view of head (epitocous). *f*, Ventral view of head (epitocous). *g*, Anterior unmodified foot (epitocous). *h*, Foot from middle region (epitocous). *i*, Swimming-bristle (epitocous). *k*, Simple ribbed bristle from terminal segments (epitocous). *l*, Head from above (semi-epitocous). *m*, Ventral view of proboscis (semi-epitocous). *n*, Foot from middle region (semi-epitocous).

TEXT-FIG. 10.


0·25MM
a
0·02MM.
c
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d
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e
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f
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h
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i
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n

but in *pulchella* the pale lenticular patches in the middle are absent. Again in *pulchella* the curious dorsal homogomph falciger found in the atocous form is present in the anterior unmodified region (Text-fig. 10*g*), and this bristle is absent in *polyscalma*. The fringes of the swimming-bristles in *polyscalma* are very coarse and easy to distinguish even at a low magnification; in *pulchella* (Text-fig. 10*h* and *i*) they are very fine and difficult to see, and the terminal, simple, ribbed bristles (Text-fig. 10*k*) are finer in *pulchella*. Finally the tentacles in *pulchella* are conical and not cirriform as in *polyscalma* and the tentacular cirri are relatively much longer, the longest reaching back as far as the 12th chætiger. The pygidium in my specimen is destroyed and therefore not available for comparison.

In the semi-epitocous specimen the eyes are greatly enlarged, and though the prostomium is much distorted by the eversion of the proboscis (Text-fig. 10*l* and *m*), it can be seen that the palps and tentacles are turned downwards. This specimen is clearly conspecific with the atocous specimens, and a careful comparison with the male heteronereid has convinced me that this also is of the same species. In both the first 14 chætigers are unmodified, both have the homogomph falciger in the dorsal ramus, in both the dorsal cirri of the first 7 chætigers show a similar change. In both the modified epitocous feet (Text-fig. 10*n*) are similar. In the semi-epitocous male the swimming-bristles are just beginning to appear in the dorsal ramus only, and traces of the fringe of teeth can with difficulty be made out. Unfortunately the specimen is incomplete posteriorly, so that I cannot look for simple ribbed bristles in the terminal segments.

In the atocous phase this species is very close to *P. dumerilii*. Fauvel (*loc. cit.*) has described it as "*tout au plus, une simple variété de* P. dumerilii", and says that it differs from *P. dumerilii* in having slightly shorter tentacular cirri, a single row of paragnaths in Group VI, the pedal glands more or less fused into a bilobed mass, and finally in having a rather more massive and curved type of dorsal homogomph falciger. Actually in *P. dumerilii* the head of the bristle is notched and the ligament attached basally at a point distal to the edge of the articular cup, whereas in *pulchella* the tip of these bristles curves over quite smoothly and the basal attachment of the terminal ligament is made at the edge of the articular cup.

Although in their atocous phase *P. dumerilii* and *P. pulchella* are very close and even difficult to separate, the heteronereids of the two species are quite different, and it is interesting to find such marked differences in the sexual phase of two forms so very similar in their asexual condition.

I am of the opinion that the heteronereids described by Holly (*loc. cit.*) as *Platynereis pestai* from Hawaii are also the epitocous form of Gravier's *P. pulchella*.

Genus *Ceratonereis* Kinberg.

Ceratonereis mirabilis Kinberg.

Fauvel, 1932, p. 98.

Occurrence:

St. 27, Gulf of Aden, 37–91 m. (1).

St. 141, Maldives, 44 m. (2).

Distribution.—West Indies, Indian Ocean, Australia, New Zealand, Maldives.

Genus *Leonnates* Kinberg.

Leonnates jousseaumei Gravier.

Fauvel, 1932, p. 85.

Occurrence :

St. M.B. Ib, Red Sea, 29 m. (3).

St. M.B. Id, Red Sea, 26 m. (4).

Distribution.—Red Sea, Persian Gulf, Bay of Bengal, Arabian Sea.

Remarks.—These are all small, fragmentary specimens.

Family Nephthydidæ.

Genus *Nephthys* Cuvier.

Nephthys dibranchis Grube.

Fauvel, 1932, p. 117, with citations

Occurrence :

St. 28, Gulf of Aden, 201 m. (1).

St. 70, Gulf of Oman, 196 m. (1).

St. 139, Maldives, 51 m. (1).

St. 179b, Gulf of Aden, 275 m. (1).

St. 190, Gulf of Aden, 183 m. (6).

St. 191, Gulf of Aden, 274 m. (6).

St. 207, Red Sea, 375 m. (1).

Distribution.—Indian Ocean, New Zealand, Australia, South America.

Remarks.—This is a common species in this area. I have counted the rows of papillæ on those specimens that have the proboscis everted, and the number is constantly 22.

Nephthys inermis Ehlers.

Fauvel, 1923, p. 375, fig. 147 *a–f*; and 1933, p. 47, fig. 3 *a–d*.

Occurrence :

St. 80, South Arabian Coast, 16–22 m. (5).

St. 164, Maldives, 183 m. (1).

St. 178, Gulf of Aden, 91 m. (1).

Distribution.—Atlantic, Gulf of Mexico, Gulf of Suez, South Arabian Coast, Maldives, Gulf of Aden.

Remarks.—Fauvel (*loc. cit.*, 1933) records this species from the Red Sea. Moreover, I find far back in the pharynx a pair of narrowly oblong, transverse, chitinous plates which I take to be the jaws mentioned by him, and which Ehlers failed to find. The hinder pair of minute tentacles I find more laterally situated than Fauvel figures them. In specimens with the proboscis withdrawn they lie at the lateral edges of the prostomium, a little way in front of the eyes.

Family Glyceridæ.

Genus *Glycera* Savigny.

Glycera rouxii Audouin and Milne-Edwards.

Fauvel, 1923, p. 389, fig. 153 *a–c* ; and 1932, p. 128.

Occurrence :

St. 72, Gulf of Oman, 73 m. (2).
St. 137, Maldives, 46 m. (1).
St. 142b, Maldives, 37 m. (1).
St. 144, Maldives, 31 m. (1).
St. 160, Maldives, 37 m. (4).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Japan.

Remarks.—This is a common and very widely distributed species. The posterior lobes of the feet are subequal in the anterior region, the lower being shorter and blunter than the upper. In the hinder region the difference between the two lobes increases. There is a single, cirriform, retractile branchia on the anterior face of the feet.

Glycera subœnea Grube.

Fauvel, 1919, p. 425, pl. xvi, figs. 48–51.

Occurrence :

St. 180, Gulf of Aden, 397 m. (1).

Distribution.—Philippines, Madagascar, Gulf of Aden.

Remarks.—The specimen has 3–4 branched retractile gills issuing from the anterior face of the foot.

Glycera lancadivæ Schmarda.

Willey, 1905, p. 286, pl. v, figs. 113–116.
Fauvel, 1932, p. 125.

Occurrence :

St. 45, South Arabian Coast, 38 m. (2).

Distribution.—Ceylon, Maldives, Laccadives, Arabian Coast.

Remarks.—Two anterior fragments. The foot has a single posterior lobe, slightly emarginate in the middle. There are no branchiæ.

Genus *Goniada* Audouin and Milne-Edwards.

Goniada multidentata Arwidsson var. *indica* var. nov.

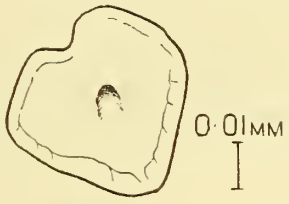
Occurrence :

St. 16, Gulf of Aden, 186 m. (1).

Distribution.—West Africa, Gulf of Aden.

Description.—The specimen is an anterior fragment measuring 25 mm. by 2 mm. without the feet for 69 chætigers. The pharynx carries about 45 chevrons on each side, and on the partly everted proboscis they extend from a point about a third of the way down the prostomium to the 16th chætiger. The macrognaths have 6 teeth, and there

are about 26 micrognaths arranged in two irregular rows of larger and smaller plates. The change from the uniramous to the biramous condition begins at the 36th chætiger and is complete at the 43rd, where the true hinder region begins. The dorsal bristles are acicular. The feet are as figured by Arwidsson (1899, p. 45, pl. iii, figs. 40–42, and pl. iv, fig. 63) for the stem-form. The present variety differs from the African form in having the armature of the proboscis more or less reduced by a half. Arwidsson gives



TEXT-FIG. 11.—*Goniada multidentata* Arwidsson var. *indica* var. nov. Papilla from proboscis.

90 chevrons, 12 teeth to the macrognaths and roughly 4 rows of micrognaths—double the number throughout of those in the present form.

The papillæ on the proboscis (Text-fig. 11) are cordiform with a central canal.

Goniada eximia Ehlers.

Ehlers, 1901, p. 157, pl. xx, figs. 7–17.
Monro, 1936, p. 141, fig. 25 *a–j*.

OCCURRENCE :

St. 85, North Arabian Sea, 1519–1705 m. (1).

DISTRIBUTION.—Magellan, Falkland Islands, Arabian Sea.

REMARKS.—The single specimen is complete, and measures about 250 mm. by 4 mm. without the feet for 252 chætigers. There are 18 pairs of chevrons, and this confirms Ehlers's contention that chevrons are present in young specimens. The macrognaths have 5 teeth, and there are about 30 micrognaths arranged in two irregular rows of larger and smaller plates. The change from the uniramous to the biramous condition begins at the 58th chætiger and is complete at the 96th where the true hinder region begins. The feet are as figured by Ehlers and myself. The dorsal bristles are capillary. The papillæ on the proboscis are more or less kidney-shaped with a central canal.

It is interesting to find this Magellan region species below the 1500-m. line in the Indian Ocean. One would like to know whether it grows in the tropics to the gigantic size to which it attains in the temperate zone.

Goniada longicirrata (?) Arwidsson.

Arwidsson, 1899, p. 47, pl. iii, figs. 43, 44.

OCCURRENCE :

St. 80, South Arabian Coast, 16–22 m. (1).

St. 206, Red Sea, 256 m. (1).

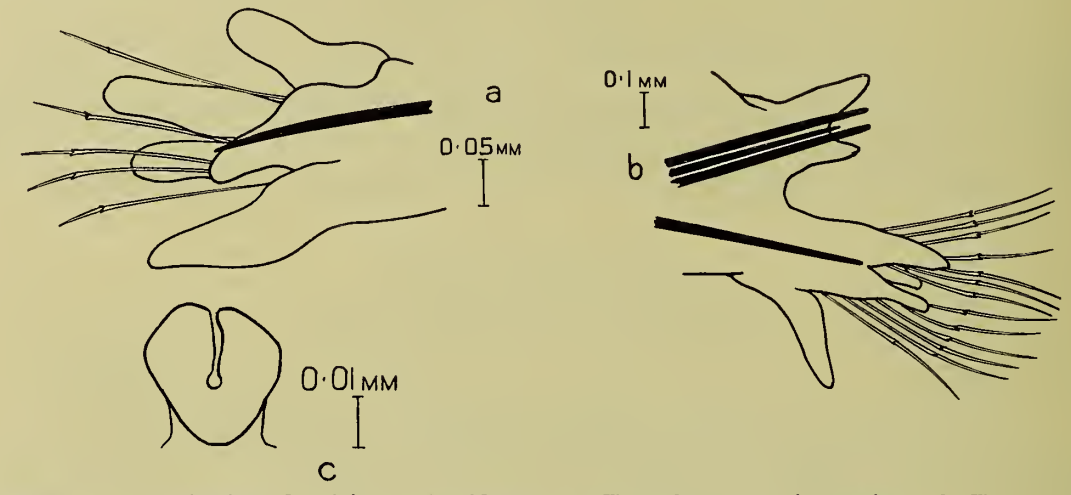
DISTRIBUTION.—West Africa, Red Sea, South Arabian Coast.

REMARKS.—The specimen from St. 206 is complete, and measures 40 mm. by 1 mm. without the feet for 145 chætigers. There are between 12 and 18 pairs of chevrons. There is the usual ring of paragnaths in the proboscis. The macrognaths have 3 teeth, and

there are about 22 micrognaths arranged in 2 irregular rows of larger and smaller plates. The change from the uniramous (Text-fig. 12*a*) to the biramous (Text-fig. 12*b*) condition of the feet takes place at the 58th chætiger and there is no intermediate region.

The feet are of the usual shape, with a ventral ramus having 2 anterior and a single posterior lobe. They closely resemble those of *G. emerita*, and do not show the elongation of the dorsal cirrus described and figured by Arwidsson. The papillæ (Text-fig. 12*c*) of the proboscis are roughly triangular in outline, and have a passage running up from the exterior to the central canal.

These specimens are very doubtfully attributed to Arwidsson's species. Arwidsson's description was based on a specimen in bad condition and he could find neither chevrons nor dorsal paragnaths, both of which are present in these examples. Moreover there is no



TEXT-FIG. 12.—*Goniada longicirrata* Arwidsson. *a*, Foot from anterior region. *b*, Foot from hinder region. *c*, Papilla from proboscis.

elongation of the dorsal cirrus such as Arwidsson describes. My specimens agree, however, with Arwidsson's in the place of origin of the biramous region. They may belong to *G. emerita*, but the biramous region begins a little further forward than is normally found in *G. emerita*, and the number of the teeth (3) of the macrognaths is low for that species.

Family EUNICIDÆ.

Genus *Eunice* Cuvier.

Eunice indica Kinberg.

Crossland, 1904, p. 318, pl. xxi, figs. 9–12, and text-figs. 61–64.
Fauvel, 1932, p. 139.

OCCURRENCE :

St. 45, South Arabian Coast, 38 m. (1).
St. 53, South Arabian Coast, 13·5 m. (2).
St. 75, Gulf of Oman, 201 m. (1).
St. 144, Maldives, 31 m. (2 juv.).

DISTRIBUTION.—Red Sea, Indian Ocean, Japan, New Caledonia.

Remarks.—The most easily appreciable difference between this species and the similar *E. australis* is the prolongation of the guard of the compound bristles into a kind of spike. The absence of annulation of the tentacles is deceptive, for the larger specimen from St. 53 has the tentacles much contracted, which gives them the appearance of annulation, and in young specimens of *E. australis* the annulation of the tentacles is often not obvious.

Eunice australis Quatrefages.

Eunice murrayi McIntosh, Crossland, 1904, p. 310.
Eunice australis Fauvel, 1917, p. 228, text-fig. 21; and 1932, p. 139.

Occurrence :

St. M.B. Id, Red Sea, 26 m. (12).
St. 10, Red Sea, 55 m. (8).
St. 27, Gulf of Aden, 37–91 m. (1).
St. 43, South Arabian Coast, 83–100 m. (1).
St. 45, South Arabian Coast, 38 m. (12).
St. 53, South Arabian Coast, 13·5 m. (7).

Distribution.—Indian Ocean, South Africa, Australia, New Zealand.

Remarks.—This is the commonest Eunicid in the present collection. Many of the specimens are young, and measure 12–15 mm. in length for about 70 chætigers. The specimens from St. 10 are uniformly dark red in colour, and I take this to be due to some extraneous staining.

Eunice antennata Savigny.

Crossland, 1904, p. 312, pl. xxii, figs. 1–7, and text-figs. 56–60.
Fauvel, 1932, p. 138.

Occurrence :

St. M.B. Ib, Red Sea, 29 m. (2).

Distribution.—Red Sea, Indian Ocean, Pacific.

Remarks.—In both these specimens the gills are reduced to a single filament in the middle region and increase to 3 filaments posteriorly.

Eunice tentaculata Quatrefages.

Fauvel, 1917, p. 209, text-fig. 17; and 1932, p. 134.

Occurrence :

St. 45, South Arabian Coast, 38 m. (4).

Distribution.—Indian Ocean, Australia, New Zealand.

Remarks.—Four anterior and one posterior fragments. All have the white collar on the 4th chætiger. The gills begin on the 3rd foot, and in the largest specimen already have 5 filaments. The maximum number of filaments is 20–23. The white collar and the annulation of the tentacles are the only means of distinguishing this species from examples of *E. aphroditois* of similar size, and it does not seem to me certain that the two species are distinct. Furthermore this species is doubtfully separable from *E. torquata* Quatrefages.

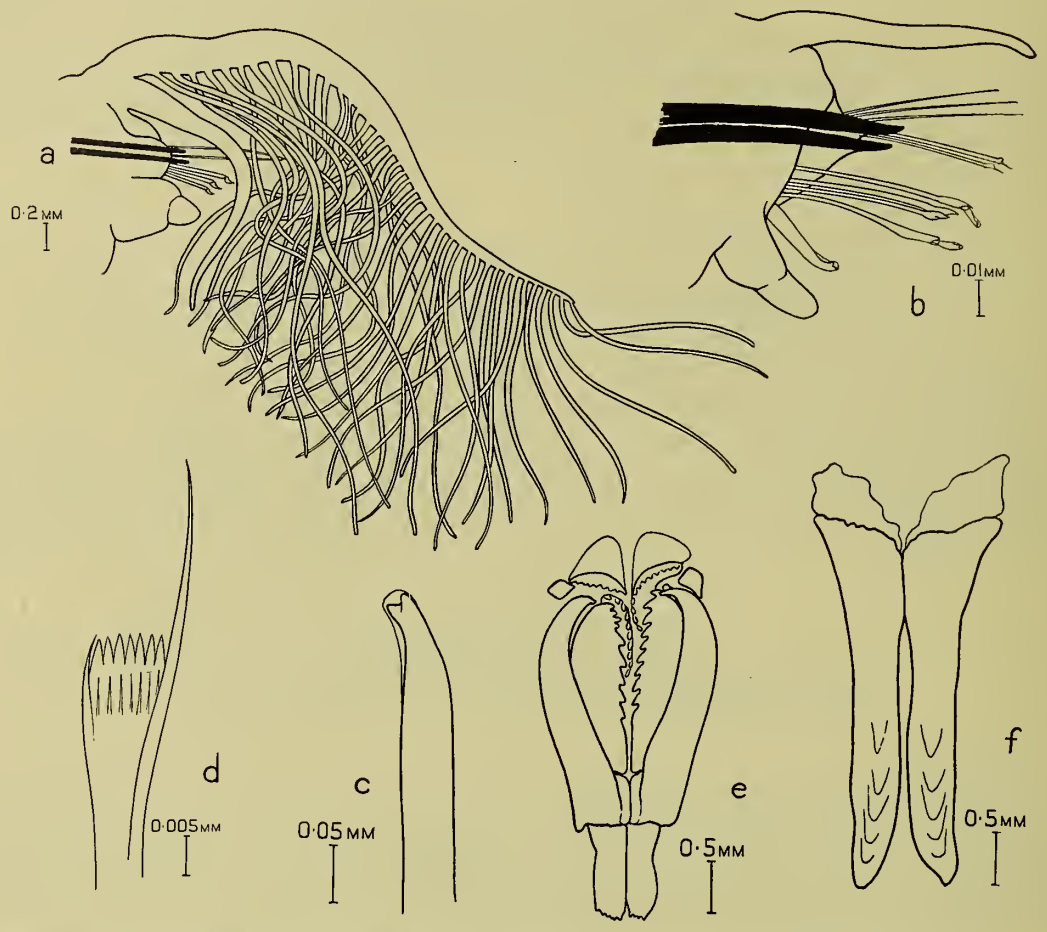
Eunice validobranchiata n. sp.

Occurrence :

St. 54, South Arabian Coast, 1046 m. (5).

Distribution.—South Arabian Coast.

Description.—Colour in spirit pale green, with a dark green stripe running down the mid-ventral line. The longest, apparently almost complete fragment measures 82 mm.



Text-fig. 13.—*Eunice validobranchiata*. *a*, 10th foot. *b*, Foot from hinder region. *c*, Sub-acicular hook. *d*, Comb-chæta. *e*, Upper jaws. *f*, Lower jaws.

by 4 mm. for 102 chætigers : three fragments which I believe together to have constituted a single individual have a total measurement of 88 mm. by 5 mm. at the widest part for 135 chætigers. The largest individuals are represented by fragments measuring 6 mm. in width at the widest part without the feet.

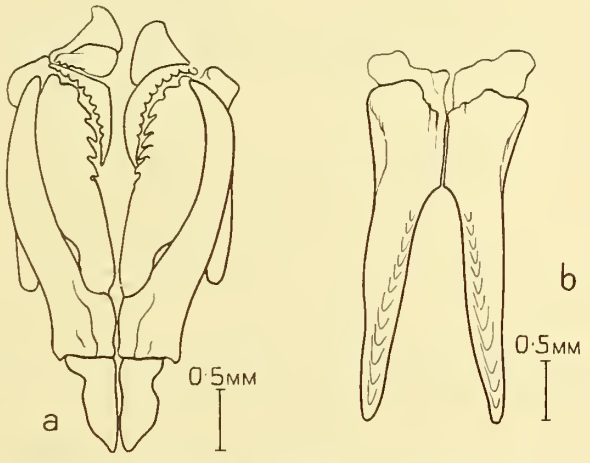
The palps are bilobed. The tentacles and tentacular cirri are smooth. The median tentacle reaches back to about the 10th chætiger and the laterals are a little shorter than this. The buccal segment is twice as long as that which follows.

The gills form a dense and conspicuous cluster over the dorsal surface of the anterior region. They begin on the 3rd chætiger and cease between the 45th and 50th. They are already highly pectinate at the 3rd chætiger, and in one specimen the 1st gill has 17 filaments. They show their greatest development between the 5th and 25th chætigers

(Text-fig. 13*a*), and in the larger specimens have a maximum of no less than 40–45 filaments. The individual filaments vary in length, but a number in each gill are about two-thirds as long as the rachis.

The dorsal cirri are long and slender, and the ventral are the usual conical processes surmounting the glandular pads except in the first 5–6 chætigers and in the hinder region (Text-fig. 13*b*), where they are digitiform. The feet are supported by 2 or 3 yellow acicula with curved tips. The subacicular hook (Text-fig. 13*c*) is yellow and bidentate and begins at about the 40th chætiger. The guard of the compound bristles is continued to a point beyond the end of the hook. This is much more marked in some specimens than in others. The comb-chætæ (Text-fig. 13*d*) have one side prolonged and 8 to 12 teeth. The jaws (Text-fig. 13*e* and *f*) are as figured. The dental formula is 9–10 : 10 + 7–12.

Remarks.—In the distribution of the gills and in the possession of bidentate yellow subacicular hooks this species agrees with *E. savignyi* Grube, but is distinguished by the extraordinary development of the gills with their very long filaments. In fact for their size these specimens have much more highly developed gills than any *Eunice* that I know.



Text-fig. 14.—*Eunice investigatoris* Fauvel. *a*, Upper jaws. *b*, Lower jaws.

Eunice investigatoris Fauvel.

Fauvel, 1932, p. 137, text-fig. 19 *a–f*.

Occurrence :

St. 54, South Arabian Coast, 1046 m. (9).

Distribution.—Persian Gulf, South Arabian Coast.

Remarks.—There are 9 anterior and several posterior fragments. That belonging to the largest individual has a width of 7 mm. at the widest part without the feet. In their general appearance they bear a striking resemblance to the specimens of *E. validobranchiata*, together with which they were taken. They agree very well with Fauvel's account, the ramified gills in the hinder region having a highly characteristic appearance.

The gills all begin on the 6th chætiger, and in the largest specimen at the 18th chætiger have about 25 filaments apart from secondary ramifications. Fauvel gives the 44th–45th feet as the point of origin of the subacicular hook. I find them beginning rather further forward, usually at about the 35th chætiger. Fauvel's material was inadequate for the investigation of the jaws (Text-fig. 14*a* and *b*), which I figure. The dental formula is 6–7 : 8 + 3–9.

Genus *Marphysa* Quatrefages.

Marphysa simplex Crossland.

Crossland, 1903, p. 140, pl. xv, figs. 11, 12, text-figs. 13, 14.

Occurrence :

St. 104, Zanzibar, 207 m. (1).

Distribution.—Zanzibar.

Remarks.—The specimen is incomplete, and measures 48 mm. by 5 mm. for 92 chætigers. The prostomium is only slightly notched in front, less so than in Crossland's specimens, and a median dorsal groove is barely indicated. There are no eyes, wherein it differs from the types. The tentacles are a little less than twice as long as the head. The body is more or less rounded throughout and shows little flattening. The gills begin on the 43rd chætiger and show a maximum of 3 filaments. The brown, simple-pointed, subacicular chæta appears at the 65th chætiger. The compound bristles have cultriform blades only. The acicula are dark brown, and the comb-bristles have long lateral teeth.

This species is close to *M. sanguinea*, but differs in having the body more or less rounded throughout and in having a different type of comb-bristle.

Genus *Lysidice* Savigny.

Lysidice collaris Grube.

Fauvel, 1932, p. 143, with synonymy.

Occurrence :

St. 157, Maldives, 229 m. (1).

Distribution.—Red Sea, Indian Ocean, Pacific, Japan, Australia.

Genus *Onuphis* Audouin and Milne-Edwards.

Onuphis furcatoseta n. sp.

Occurrence :

St. 16, Gulf of Aden, 186 m. (9).

St. 70, Gulf of Oman, 196 m. (1).

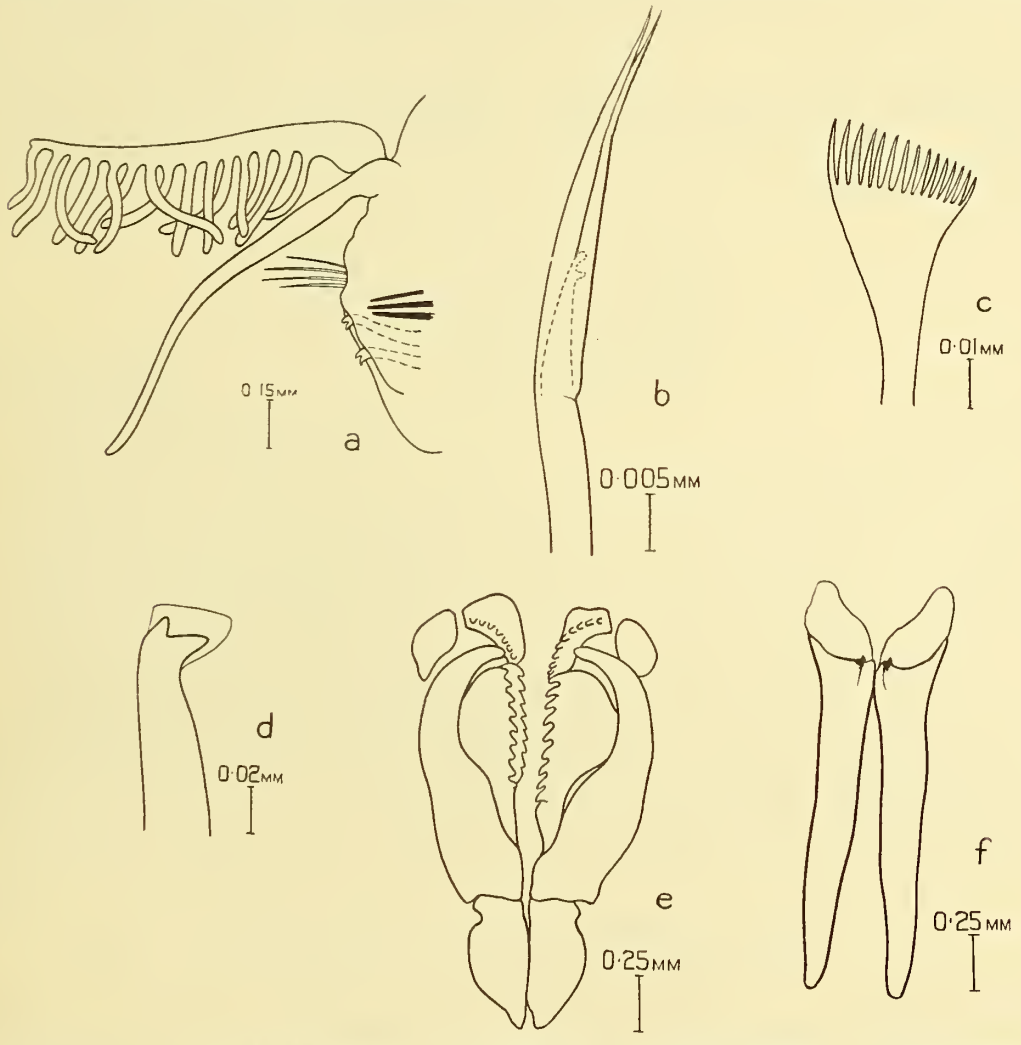
St. 75, Gulf of Oman, 201 m. (1).

St. 207, Red Sea, 375 m. (1).

Distribution.—Gulf of Aden, Gulf of Oman, Red Sea.

Description.—All the specimens are incomplete, and the largest measures 35 mm. by 3 mm. for about 85 chætigers. St. 16 yielded a large number of tubes formed of mud, and the specimens extracted from these are all in bad condition. Those freshly extracted from their tubes show a well-defined colour pattern. There is a brown streak running from the base of the median tentaculophore to the hinder limit of the head, and there are brown transverse segmental bands across the back in the anterior region. Between the inner and outer lateral tentacles there is on each side a small group of minute dots which I take to be ocular. In specimens from stations other than 16 the colour pattern has disappeared.

The body is cylindrical for the first few segments and then shows a flattening dorsally. The palps are globular and the frontal tentacles ovate. The occipital tentacles have short tentaculophores; the median and inner laterals reach back to about the 10th chætiger and the outer laterals are about a third of this length. The buccal segment carries a pair of tentacular cirri which reach back almost to the hinder border of the first chætiger. Dorsal cirri long, slender, subulate, about equal to the branchiæ in the middle



TEXT-FIG. 15.—*Onuphis furcatoscta*. *a*, Twelfth foot. *b*, Forked bristle. *c*, Comb-bristle. *d*, Subacicular hook. *e*, Upper jaws. *f*, Lower jaws.

region. Ventral cirri digitiform in front, disappearing at about the 10th chætiger. Posterior lip of the chæta-sac cirriform for the first 5 chætigers. The gills have a woolly appearance. They begin usually with two minute filaments at the 3rd chætiger, rapidly increase until they reach their maximum development (of about 18 filaments in one of the larger specimens) at about the 15th chætiger (Text-fig. 15*a*), and remain highly ramified probably to the end of the body. None of the specimens is complete, but they are still well developed at the 85th chætiger.

The first 3 chætigers have flattened capillary bristles, and the place of the usual

compound hooks is taken by curious simple or incipiently pseudo-compound bristles having a very slight and scarcely noticeable notch marking the place where the usual articulation is found, and very long hoods, the ends of which are prolonged into two tapering points which form a terminal fork (Text-fig. 15*b*). Inside the hood an ill-defined bidentate hook can with difficulty be seen, and there is no clear distinction discernible between the hood and the hook which it contains. The following chætigers have capillary bristles, and from the middle region onwards comb-bristles (Text-fig. 15*c*) with about 15 teeth. At the 9th chætiger there appears a pair of yellow hooded bidentate subacicular hooks (Text-fig. 15*d*).

I figure the jaws (Text-fig. 15, *e* and *f*). The dental formula is 9–9 : 8 + 7–9.

Remarks.—The curious anterior chætæ with forked tips and the highly ramified woolly gills are unlike those of any other *Onuphis* that I know.

Onuphis aucklandensis Augener.

Augener, 1924, p. 418, fig. 11 *a–e*.
Fauvel, 1932, p. 146.
Monro, 1936, p. 152.

Occurrence :

St. 190, Gulf of Aden, 183 m. (1).

Distribution.—New Zealand, India, Gulf of Aden.

Remarks.—The specimen is in two pieces, which together measure 28 mm. by 1 mm. for 77 chætigers. I take it to be a young example of Augener's species. The colour pattern is very conspicuous. There are reddish-brown spindle-shaped markings across the dorsal surface of every segment. They are more intense anteriorly but are continued to the end of the fragment. There are also dark brown patches below the feet. The gills begin with a single filament on the 2nd chætiger, are ramified by the 4th and show a maximum of 4 filaments. The pseudo-compound hooks are continued to the 5th chætiger as in my New Zealand specimens.

Onuphis eremita Audouin and Milne-Edwards.

Fauvel, 1923, p. 414, fig. 163 *a–l* ; and 1932, p. 146.

Occurrence :

St. 80, South Arabian Coast, 16–22 m. (3).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Remarks.—Three anterior fragments.

Onuphis sp.

Occurrence :

St. 118, Zanzibar, 1789 m. (numerous tubes).

Remarks.—A large number of parchmenty tubes, to many of which long sponge-spicules are attached. Nearly all are empty, and the few specimens that I have extracted are too badly preserved to be determinable. The anterior crochets are large, simple hooks resembling those of *O. conchylega*, to which species the specimens may very well belong.

Genus *Diopatra* Audouin and Milne-Edwards.

Diopatra neapolitana Delle Chiaje.

Fauvel, 1923, p. 419, fig. 166 *a–h* ; and 1932, p. 144.

Occurrence :

St. 45, South Arabian Coast, 38 m. (2).

St. 72, Gulf of Oman, 73 m. (1).

St. 75, Gulf of Oman, 201 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Remarks.—These are anterior fragments, and I can add nothing to Fauvel's careful study of this species.

Genus *Hyalinœcia* Malmgren.

Hyalinœcia tubicola (O. F. Müller).

Fauvel, 1923, p. 421, fig. 166 *i–q* ; and 1932, p. 149.

Occurrence :

St. M.B. IIc, South Arabian Coast, 29 m. (4).

St. 33, Gulf of Aden, 1295 m. (3).

St. 54, South Arabian Coast, 1046 m. (1).

St. 62, North Arabian Sea, 1893 m. (4).

St. 85, North Arabian Sea, 1519–1705 m. (4).

St. 118, Zanzibar, 1789 m. (1).

St. 141, Maldives, 44 m. (1).

St. 157, Maldives, 229 m. (1).

St. 184, Gulf of Aden, 1270 m. (empty tubes).

St. 185, Gulf of Aden, 2000 m. (empty tubes).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Japan, New Zealand.

Remarks.—Nearly all these specimens are in poor condition and I can add nothing to the accounts of this well-known species. The gills begin between the 18th and 20th chætigers.

Genus *Rhamphobrachium* Ehlers.

Rhamphobrachium bipes n. sp.

Occurrence :

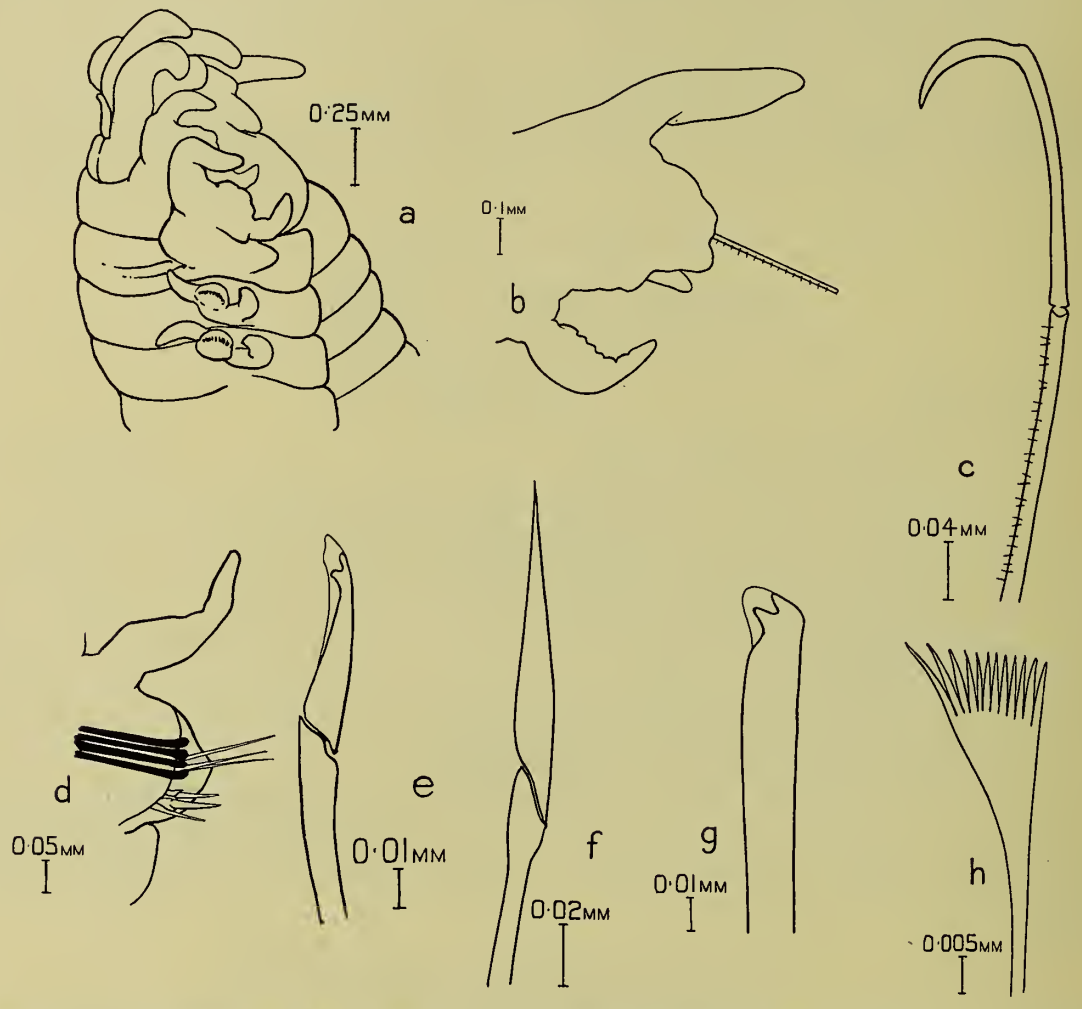
St. 178, Gulf of Aden, 91 m. (1).

Distribution.—Gulf of Aden.

Description.—An anterior fragment in rather bad condition, measuring 16 mm. by 2 mm. for 45 chætigers. It presents certain unusual features, which justify description in spite of the poverty of the material. The body is more or less cylindrical, and in spirit there is no colour. The palps consist of a pair of transversely elongate lobes, and there is a pair of flattened semi-ovate frontal tentacles. The occipital tentacles are short and stumpy, and their tentaculophores occupy about a third of their length. The median and inner lateral tentacles reach back to the 3rd chætiger, and the outer laterals are about two-thirds of this. There is a pair of eyes situated between the bases of the lateral

tentacles. From the front border of the buccal segment there arises a pair of tentacular cirri reaching a little beyond the bases of the inner lateral tentacles.

Only the first 2 feet are modified (Text-fig. 16*a*), and not the first three as is usual in the genus. These are elongate, and carried forward at the sides of the head. They have stout dorsal and ventral cirri, and at the base of the distal edge of the first foot (Text-fig. 16*b*) there is a conical papilla. I cannot see any dorsal or apical papillæ and the



TEXT-FIG. 16.—*Ramphobrachium bipes*. *a*, Side view of anterior region. *b*, 1st foot. *c*, Hook from 2nd foot. *d*, 6th foot. *e*, Compound bidentate bristle from 3rd foot. *f*, Compound bristle from 6th foot. *g*, Bidentate hook. *h*, Comb-bristle.

ventral papilla present on the first foot is not apparent on the second foot, but it should be said that these feet have undergone some distortion. The ventral cirrus is converted into a pad by the 5th foot, and there is no cirriform prolongation of the posterior lip of the chætal lobe. The first 2 chætigers carry long bristles (Text-fig. 16*c*), having curved tips, a small boss below the terminal curved region and below the boss 2 rows of spinelets. I cannot see a tridentate hook such as Augener (1927, text-fig. 8) figures for *R. chuni*. The 3rd foot is similar to those that follow (Text-fig. 16*d*). It carries capillary bristles, hooded bidentate compound bristles (Text-fig. 16*e*) and comb-bristles, and is supported by 4 yellow acicula, which in the present specimen have their ends broken. The

hooded, bidentate, sickle-shaped, compound bristles are confined to the third foot. The 4th foot and the next few chætigers, the exact number of which I have not determined, are supported by 3 or 4 yellow acicula with expanded lanceolate tips and carry capillary bristles, compound bristles with cultriform blades (Text-fig. 16*f*) and a few comb-bristles. Behind this the compound bristles disappear, their place being taken by a pair of large bidentate hooks (Text-fig. 16*g*), and the tips of the acicula are no longer expanded, but slender and pointed. The comb-bristles (Text-fig. 16*h*) have about 12 teeth.

The dorsal cirri are slender and subulate. The gills begin with a single filament already longer than the dorsal cirrus at the 7th chætiger. They are bifid at the 10th chætiger and show 5 filaments at about the 40th chætiger.

The material does not permit me to examine the jaws. The specimen is accompanied by a soft tube encrusted with fine sand and shell.

Remarks.—This species is at once distinguished from all other members of the genus by the fact that only the first 2 feet and not the first 3 are modified.

Rhamphobrachium diversosetosum n. sp.

Occurrence :

St. 163, Maldives,274 m. (1).

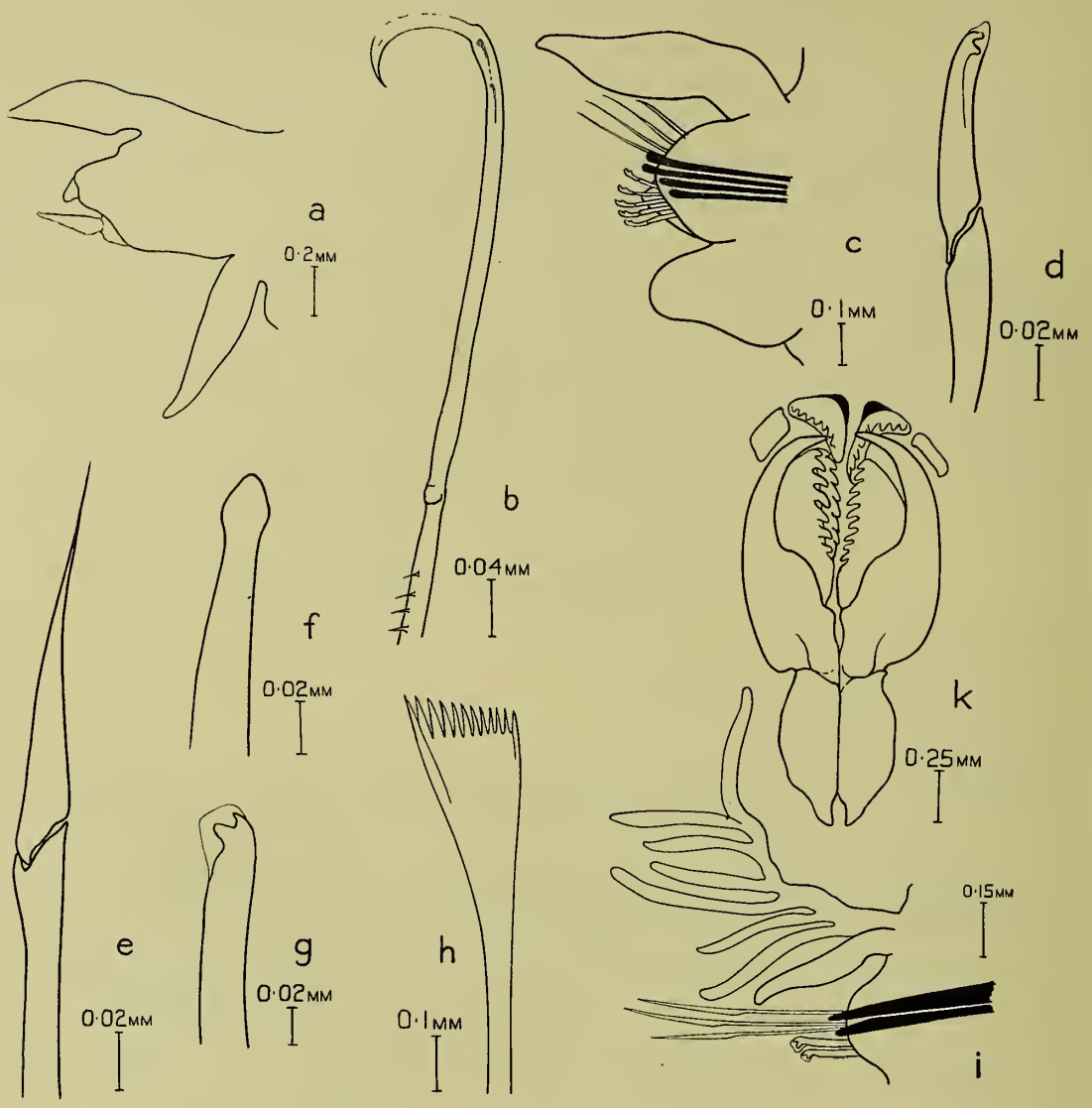
St. 164, Maldives, 183 m. (1).

Distribution.—Maldives.

Description.—Both specimens are incomplete. The larger measures 30 mm. by 3 mm. for 52 chætigers and the smaller 19 mm. by 3 mm. for 36 chætigers. The body is more or less cylindrical. The palps and frontal tentacles are marked with black dorsally, there is a black ring round the occipital tentacles just above the tentaculophores, and there are splashes of black on the ventral surface of the buccal and the following 3 segments. The palps are globular, and the frontal tentacles ovate. The occipital tentacles are slender and have short tentaculophores. The median and the inner lateral tentacles reach back to the 4th chætiger, and the outer laterals are about two-thirds of this. There is a pair of small eye-spots between the lateral tentacles. The buccal segment carries a pair of tentacular cirri reaching halfway up the tentaculophores of the inner lateral tentacles.

The first 3 feet (Text-fig. 17*a*) are elongated and carried forward beside the head. They have large dorsal and ventral cirri, and carry a cirriform process arising from the base of the distal edge of the foot. They carry the enormously long bristles (Text-fig. 17*b*) with curved tips characteristic of the genus. I see no tridentate hook such as Augener found in the bristles of *R. chuni*.

The ventral cirri disappear by the 7th chætiger, and the dorsal cirri are rather short and subulate. The fourth foot (Text-fig. 17*c*) carries capillary bristles and compound bidentate hooks (Text-fig. 17*d*) with sickle-shaped ends. These compound bristles are confined to the 4th foot. For about the following 10 chætigers the place of the compound bristles with sickle-shaped blades is taken by compound bristles with cultriform blades (Text-fig. 17*e*). In this anterior region the feet are supported by 4 yellow acicula (Text-fig. 17*b*) with expanded tips. Between the 10th and 20th chætigers the compound bristles disappear and their place is taken by a pair of yellow, bidentate, hooded, acicular hooks (Text-fig. 17*g*), and at the same time the 4 acicula are replaced by a pair of stout acicula with pointed ends. Comb-bristles (Text-fig. 17*h*) with about 12 teeth are present.



TEXT-FIG. 17.—*Ramphobrachium aversosetosum*. *a*, 2nd foot; bristles not shown. *b*, Hook from 2nd foot. *c*, 4th foot. *d*, Compound bidentate bristle from 4th foot. *e*, Compound bristle from 10th foot. *f*, Aciculum. *g*, Sub-acicular hook. *h*, Comb-chæta. *i*, 25th foot. *k*, Upper jaws. *l*, Lower jaws.

The gill begins with a single filament at the 10th chætiger and reaches a maximum of about 8 filaments (Text-fig. 17*i*). On the terminal segment (52nd) of the larger fragment the gills are still richly branched.

I figure the jaws (Text-fig. 17*k* and *l*). The dental formula is 7–9 : 8 + 7–7.

Remarks.—The only other species of the genus with the first 3 feet modified and compound bristles in the unmodified chætigers are *R. brevibrachiatum* (Ehlers) and *R. ehlersi* Monro. *R. brevibrachiatum* lacks the long hooks of the first 3 feet, and *R. ehlersi* has no compound bristles with sickle-shaped blades in the 4th foot. There are also other points of difference. It is allied to *R. bipes*, but differs in having the first 3 feet modified instead of the first 2.

Genus *Lumbrinereis* Blainville.

Lumbrinereis latreilli Audouin and Milne-Edwards.

Fauvel, 1923, p. 431, fig. 171 *m–r* ; and 1932, p. 152.

Occurrence :

St. M.B. IIa, South Arabian Coast, 11 m. (2).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Pacific.

Remarks.—Two small fragments which I believe to belong to young specimens of this species.

Lumbrinereis impatiens Claparède.

Fauvel, 1923, p. 429, fig. 171 *a–i* ; and 1932, p. 152.

Occurrence :

St. 149, Maldives, 238 m. (2).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Remarks.—Two small anterior fragments, which as far as they go agree with Claparède's species.

Lumbrinereis heteropoda Marenzeller.

Crossland, 1924, p. 4, text-figs. 1–7.
Fauvel, 1932, p. 153.

Occurrence :

St. 147, Maldives, 27 m. (2).

St. 194, Gulf of Aden, 220 m. (2).

Distribution.—West Africa, Indian Ocean, Pacific.

Remarks.—The specimens from St. 194 are in very poor condition and are doubtfully of this species.

Lumbrinereis quasibifilaris n. sp.

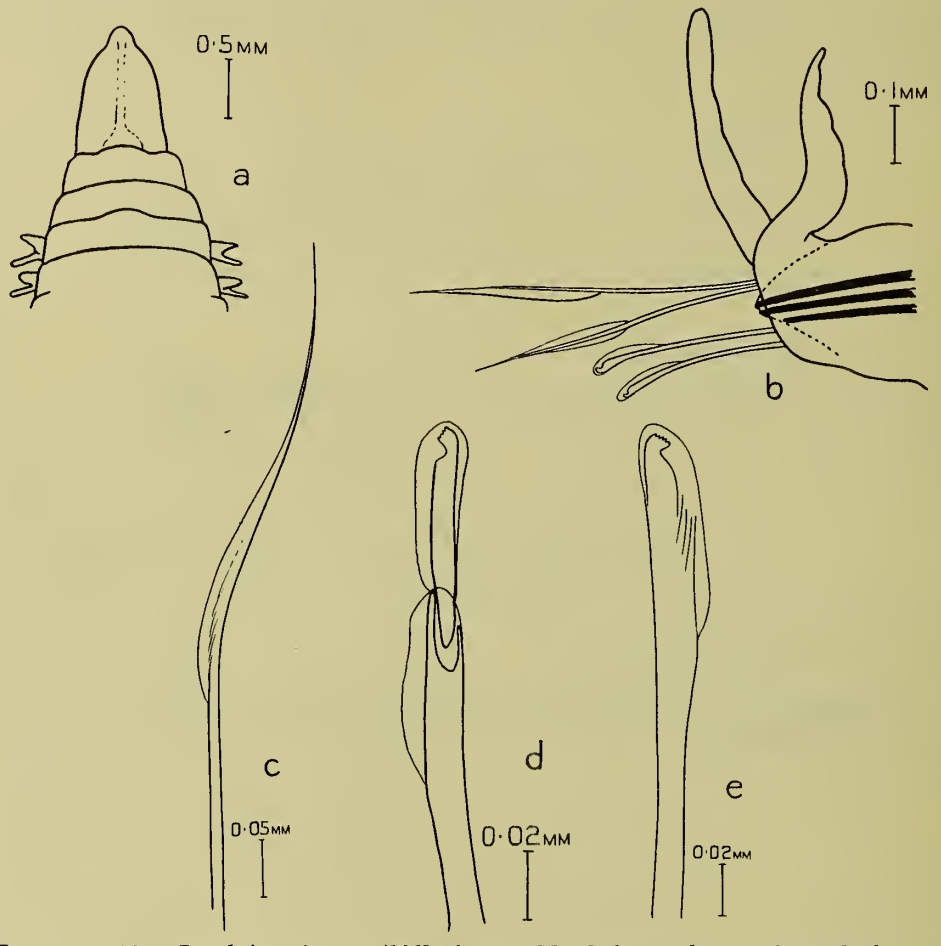
Occurrence :

St. 180, Gulf of Aden, 397 m. (1).

Distribution.—Gulf of Aden.

Description.—An anterior fragment measuring 8 mm. by 2 mm. for 26 chætigers. The colour in spirit is pale yellow and there is very little tapering of the body in front.

The prostomium (Text-fig. 18*a*) is long, lanceolate and flattened. There is a pair of mouth-pads. The buccal segment is about twice as long as the second, and the second about equal to the 1st chætiger. Ventrally the first 2 segments are involved with the mouth. The first few feet have a low rounded anterior lip and a posterior lip tapering at the tip. The tip of the posterior lip rapidly elongates from before backwards into a cirriform process. The anterior lip shows little change, until suddenly at the 8th chætiger it develops a cirriform process similar in size and shape to that of the posterior. These



TEXT-FIG. 18.—*Lumbrinereis quasibifilaris*. *a*, Head from above. *b*, 20th foot. *c*, Capillary bristle. *d*, Compound crochet. *e*, Simple crochet.

2 cirriform processes continue to elongate (Text-fig. 18*b*), until at the end of the fragment (26th chætiger) they are of considerable length. The bristles are somewhat damaged, but it can be seen that up to about the 20th chætiger they consist of winged capillaries (Text-fig. 18*c*) and *compound crochets* (Text-fig. 18*d*). Behind this the compound crochets disappear and are replaced by simple crochets (Text-fig. 18*e*).

The material does not permit me to examine the jaws.

REMARKS.—This species belongs to that group which has two long cirriform ligules to the feet. Of these Kinberg's *Larymna cirrosa* has eyes and a semi-globular prostomium and apparently no compound hooks. Ehlers' *L. bifilaris* has no compound hooks in the anterior region, and Fauvel's *L. pseudobifilaris* has no hooks at all.

Genus *Drilonereis* Claparède.

Drilonereis filum Claparède.

Fauvel, 1923, p. 436, fig. 174 *a–h* ; and 1932, p. 159.

Occurrence :

St. 28, Gulf of Aden, 201 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Family Spionidæ.

Genus *Prionospio* Malmgren.

Prionospio pinnata Ehlers.

Fauvel, 1932, p. 173, with synonymy.

Occurrence :

St. 147, Maldives, 27 m. (1).

St. 179B, Gulf of Aden, 275 m. (2).

Distribution.—Atlantic, Indian Ocean, Pacific.

Remarks.—The specimens from St. 179B are damaged in front and the prostomial wings are not very clear. They are only probably of this species.

Family Magelonidæ.

Genus *Magelona* F. Müller.

Magelona sp. juv.

Occurrence :

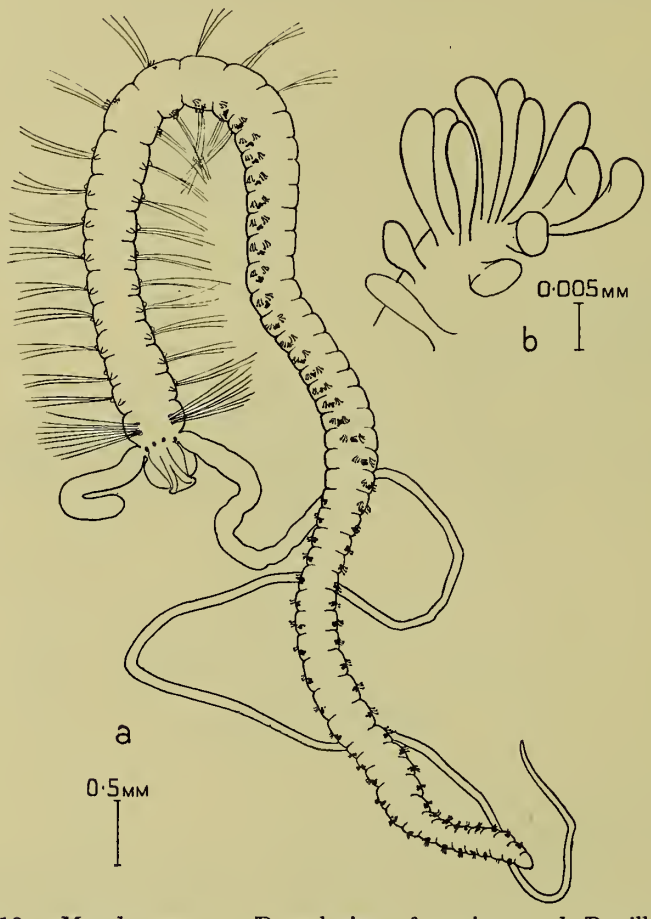
St. 145C, Maldives, 400–0 m. (1).

Distribution.—Maldives.

Description.—This small pelagic annelid (Text-fig. 19*a*), which I take to be the post-larva of a *Magelona*, measures 11 mm. by 0·5 mm. for 56 chætigers. The large prostomium is rounded, except where the keel broadens in front to form a more or less hammer-shaped process. The cephalic plate appears to be continued back as far as the 1st chætiger. There is a pair of palps, of which one is broken off short and the other, though incomplete, is a little longer than the body. Palpar papillæ are very difficult to see, especially as where the palp is contracted the rugosities may easily be mistaken for papillæ, but in one or two places I believe that I see true papillæ (Text-fig. 19*b*). Slender spine-like larval papillæ (*Stabchen*) are absent. The first 9 chætigers are distinguished by the presence of only very delicate capillary swimming-bristles in both rami. They are not all of the same size, some being very long and others short. They are quite featureless and I cannot tell whether the shorter bristles are just broken off. In the 1st chætiger these bristles are much more numerous than in the rest. In this anterior region there are a small triangular dorsal lamella and an even smaller conical ventral lamella. These lamellæ extend only to the 9th chætiger. As far as can be seen the 9th chætiger does not

differ from the rest in the anterior region, and I can see no bristles with expanded tips such as are found in *M. papillicornis*.

The 10th chætiger is characterized by the first appearance of the hooded bidentate hooks. Up to the 15th chætiger the dorsal rami still carry a bundle of capillary swimming-bristles as well as 1 or 2 hooks, and the ventral rami 2 or 3 hooks only. Behind the 15th chætiger there are about 3 hooks in both rami of the feet, and the capillary swimming-bristles are absent. In the hinder region (*i. e.* behind the 9th chætiger) I see



TEXT-FIG. 19.—*Magelona* sp. *a*, Dorsal view of specimen. *b*, Papillæ of palp.

no lamellæ of any kind, but just behind the feet there are patches of dark brown granular pigment. The body ends in a pair of small globular cirri.

REMARKS.—Owing to the difficulty of establishing with certainty the presence of true adult papillæ on the palps, I was at first inclined to regard this specimen as a post-larval Spionid, but I am now satisfied that it is a true *Magelona*. Claparède (1863, p. 74, pl. x, figs. 9–14, and pl. xi, figs. 1, 2) and McIntosh (1894, p. 66, pl. viii, figs. 1–7) have both described post-larvæ of a *Magelona*, and the present form bears some resemblance both to that figured by Claparède (pl. x, fig. 12) and to that figured by McIntosh (pl. viii, fig. 3). As far as its specific attribution goes, it is nearer to *M. pacifica* mihi (Monro, 1933*a*, text-fig. 2*a*) in the shape of its prostomium than to Gravier's Red Sea *M. obockensis*.

Family Chætopteridæ.

Genus *Phyllochætopterus* Grube.

Phyllochætopterus sp.

Occurrence :

St. 70, Gulf of Oman, 196 m. (numerous tubes).

St. 184, Gulf of Aden, 1270 m. (numerous tubes).

Remarks.—Clusters of empty tubes probably belonging to *Ph. socialis*. In the absence of a specimen this cannot be verified.

Family Cirratulidæ.

Genus *Cirratulus* Lamarck.

Cirratulus sp.

Occurrence :

St. 164, Maldives, 183 m. (1).

Remarks.—A small cirratulid in poor condition. The gills begin on the 1st chætiger, and in the one specimen are continued over about the anterior half of the body. There are the scars of about 7 pairs of tentacular filaments on the 1st and 2nd chætigers. There are no hooks. The specimen agrees with *C. filiformis* Keferstein, except in the relatively high number of tentacular filaments.

Genus *Chætozone* Malmgren.

Chætozone setosa Malmgren.

Fauvel, 1927, p. 101, fig. 35 *d–k*.

Occurrence :

St. 178, Gulf of Aden, 91 m. (1).

Distribution.—Atlantic, Mediterranean, Gulf of Aden.

Remarks.—The specimen is dark green in spirit. I cannot obtain an exact measurement, but it has a length of about 12 mm. and a width of 2 mm. at the widest part for 60 chætigers. The palps and all except two or three isolated branchial filaments are lost. I have compared it with a specimen from Spitzbergen, and within the limits of the material I can find no ground for separation. The type-material of McIntosh's *Chætozone atlantica*, *pacifica* and *benthaliana* is so much damaged as to be almost useless for purposes of identification.

Family Chlorhæmidæ.

Genus *Stylarioides* Delle Chiaje.

Stylarioides xanthotrichus (Schmarda).

Ehlers, 1908, p. 119, pl. xvi, figs. 1, 2.
Augener, 1918, p. 431, text-fig. 60.

Occurrence :

St. 45, South Arabian Coast, 38 m. (16).

St. 53, South Arabian Coast, 13·5 m. (14).

Distribution.—South-west Africa, Arabian Coast.

Remarks.—These specimens measure 15–20 mm. in length by 3 mm. in breadth at the widest part for about 60 chætigers. The segments of the tail are very difficult to count. The body is clearly divided into trunk and tail, and the trunk has about 25 chætigers. The first 2 chætigers, and to a much lesser extent the third, go to form the cephalic cage.

Text-fig. 20.—*Stylarioides xanthotricus* (Schmarda). Ventral hook of 3rd foot.

The bristles of the first 2 chætigers form a conspicuous iridescent palisade in front. The dorsal bristles of the 3rd chætiger are reduced to about 2 in number, and although they point forwards like the bristles of the first 2 chætigers, they are very much smaller and quite inconspicuous. I see only a single bristle in the ventral bundle of the 3rd chætiger, and this is a slender barred bristle with a hooked tip (Text-fig. 20). It is unlike any other bristle in the body. The dorsal bristles over the rest of the body are reduced to 1 or 2 barred capillary bristles in each notopodial bundle. They are so slender that they are difficult to see. The true hooks begin on the 4th chætiger. They are strong dark brown structures without striæ, and resemble Augener's figure. In these specimens there is never more than one in each neuropodial bundle, but they are accompanied by 3 or 4 rudimentary hooks which do not pierce the skin.

Sand-grains do not adhere to the body except at the anterior end. There is a kind of ring or collar extending over the first 3 chætigers in which the skin papillæ have a similar form to those of the shield of *St. parmatus*, and here sand-grains are usually collected. Over the rest of the body the papillæ are small and globular, and form roughly two transverse rows in each segment. None of the specimens has the gills everted, and the condition of the material internally is not suitable for dissection. As far as can be seen, the gills are attached to a semicircular membrane surrounding the base of the paired canaliculate palps.

Stylarioides hamocarens n. sp.

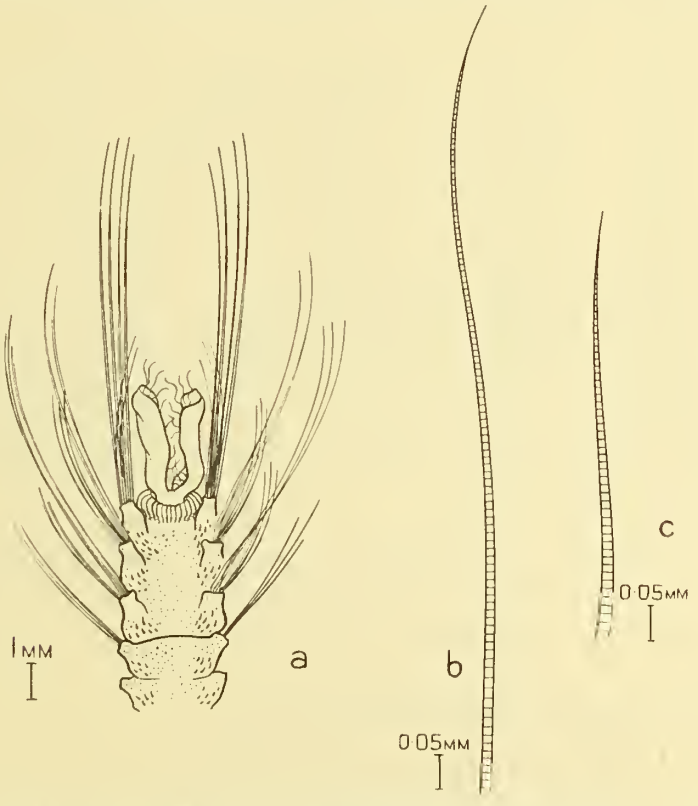
Occurrence :

St. 86, North Arabian Sea, 759–1024 m. (1).

Distribution.—Arabian Sea.

Description.—A single specimen, incomplete posteriorly and measuring 23 mm. by 3 mm. for 27 chætigers. The body is of about the same diameter throughout. In spirit the colour is dark green in front, merging into yellow behind. There are no sand-grains, and the body is dotted with small papillæ incrusted with mud at the base and with short clavate tips. In the neighbourhood of the feet there are a number of long, cylindrical papillæ. There is a well-developed cephalic cage (Text-fig. 21*a*) formed from the first 3 chætigers, which are provided with pedal lobes absent over the rest of the body. The dorsal bristles of the first 3 chætigers are immensely long, one from the 1st foot being equal in length to the first 13 chætigers. The ventral bristles of the cage are about half as long as the dorsal. Otherwise dorsal and ventral bristles are similar, both having well-marked closely-set striæ and long flagelliform tips. Dorsal and ventral bristles of the

4th chætiger are of the same type as those of the cage, but considerably smaller; they are nevertheless much longer than those of the mid-body, and there is a gradual decrease in the size of the bristles from before backwards as far as about the 8th chætiger. Here and over the rest of the body the dorsal bristles (Text-fig. 21*b*) are about as long as the body is wide, and the ventral bristles (Text-fig. 21*c*) are about half the length of the dorsal. Throughout the body dorsal and ventral bristles are of similar character, being slender, striated, and ending in fine, flagelliform tips. There is no trace of ventral hooks.



Text-fig. 21.—*Stylarioides hamocarens*. *a*, Anterior region from above. *b*, Dorsal bristle. *c*, Ventral bristle.

The gills are everted. They are very numerous and filiform and borne on two separate, divergent, stout, membranous lobes with their sides folded inwards. When unfolded, these lobes are more or less spoon-shaped in outline, but in their natural folded condition they are narrowly oblong. No palps can be seen.

Remarks.—This species has affinities with *St. bifidus* Fauvel, especially in the structure of the cephalic cage and in the bifid nature of the branchial apparatus, but differs in the total absence of ventral hooks. I know no other *Stylarioides* that has a bifid branchial apparatus and no ventral hooks.

Genus *Brada* Stimpson.

Brada villosa (Rathke).

Fauvel, 1927, p. 121, fig. 43 *e–l*.

Occurrence :

St. 79, South Arabian Coast, 95–102 m. (1).

Distribution.—Atlantic, Mediterranean, Pacific, Arabian Coast.

Remarks.—This specimen, thickly coated with sand-grains especially on the dorsal surface, measures 13 mm. by 3 mm. for 30 chætigers. I have compared it with McIntosh's examples of *Brada mammillata* Grube, to which species Fauvel (1932, p. 185) has attributed a specimen from the Arabian Sea, and with Augener's redescription (Augener, 1932, p. 54) of Grube's material. *B. mammillata* is a larger species (up to about 70 mm. in length) than *villosa*, with heavy dark brown ventral bristles, and in the hinder region conspicuous transverse rows of large skin-warts, absent in *villosa*.

Genus *Flabelligera* Sars.

Flabelligera diplochaitos (Otto).

Fauvel, 1927, p. 114, fig. 40 *g–o*.

Occurrence :

St. 43, South Arabian Coast, 83–100 m. (3).

Distribution.—Mediterranean, Arabian Coast.

Remarks.—Three damaged specimens. Within the limits of the material they agree with the Mediterranean species, which is distinguished from the Atlantic *Fl. affinis* chiefly on the possession of 4 to 6 hooks in the neuropods instead of 2. According to Fauvel this difference is constant. This species, *Fl. affinis* Sars and the South African *Fl. luctator* Stimpson are all very close.

Genus *Ilyphagus* Chamberlin.

Ilyphagus hirsutus n. sp.

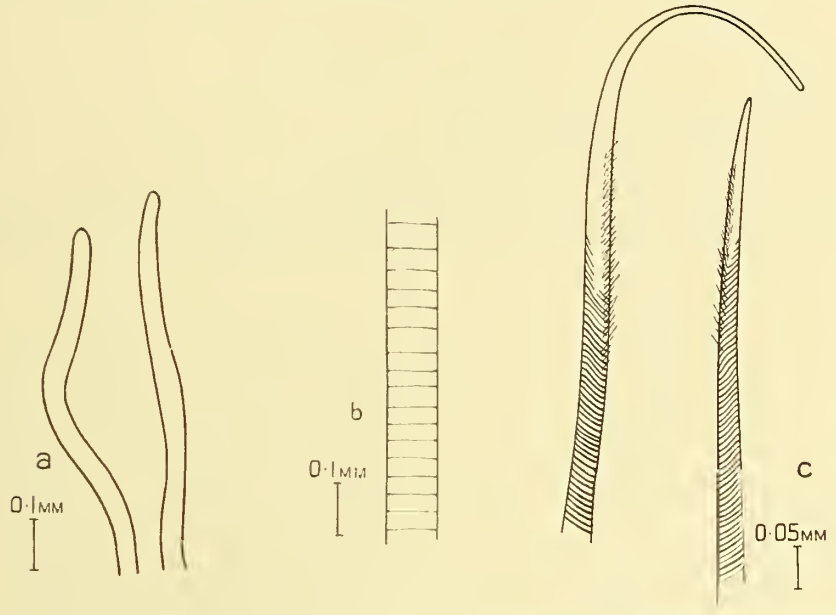
Occurrence :

St. 133, South Arabian Sea, 3385 m. (1).

Distribution.—Arabian Sea.

Description.—A sac-like creature shaped like an *Echiurus* and with a dense, uniform, fur-like covering of long, cirriform papillæ (Text-fig. 22*a*). It is pale grey in colour and to a slight extent coated with mud. The specimen is damaged and there is no trace of a prostomium, and no means externally of distinguishing the front from the hinder end. External segmentation is revealed only by the bristle-bundles, and when these are broken off their place of origin is lost among the papillæ. I have counted twelve ventral bristle-bundles on one side, and they occupy about half the length of the body. The measurements are 39 mm. by 14 mm. The dorsal bristle-bundles have disappeared except for 2 or 3 isolated bristles all broken at the end. These bristles (Text-fig. 22*b*) are very long and have the usual transverse striæ. They are very like that figured by Chamberlin (1919, pl. 69, fig. 4) for his *Ilyphagus bythincola*. The ventral bristle-bundles carry about a dozen bristles (Text-fig. 22*c*). These are shorter and stouter than the dorsal. They are obliquely striated, and many of them end in long tapering tips. In others these delicate tips are missing and the blades end in a sharp point. I assume that the absence of the tips is due to wear. In addition to the striæ towards the distal end these ventral bristles have rows of stout hairs. The body-papillæ have an external coating of varying length and thickness, composed of fine mud cemented with mucus.

Remarks.—With the present material I cannot carry the description of this species any further. It is distinguished from Chamberlin's *I. bythincola*, *I. pluto* and *I. ascendens* by the hirsute character of its ventral bristles. I suspect, however, that further material



Text-fig. 22.—*Ilyphagus hirsutus*. *a*, Papillæ. *b*, Part of dorsal bristle. *c*, Ventral bristles.

may reveal that all the three species of Chamberlin and my *hirsutus* are conspecific. *Ilyphagus* appears to be an abyssal genus.

Family Capitellidæ.

Genus *Notomastus* Sars.

Notomastus latericeus Sars.

Fauvel, 1927, p. 143, fig. 49 *a–h* ; and 1932, p. 194.

Occurrence :

St. 80, South Arabian Coast, 16–22 m. (1 juv.).

Distribution.—Atlantic, Mediterranean, Falkland Islands, Indian Ocean.

Genus *Dasybranchus* Grube.

Dasybranchus caducus Grube.

Fauvel, 1927, p. 148, fig. 52 *a–h* ; and 1932, p. 195.

Occurrence :

St. 137, Maldives, 46 m. (1).

St. 147, Maldives, 27 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Pacific.

Remarks.—I cannot discover any branchiæ in the specimen from St. 137. They are either retracted or lost, for in other respects it agrees with this species.

Family Maldanidæ.

Genus *Maldane* Grube.

Maldane cristata Treadwell.

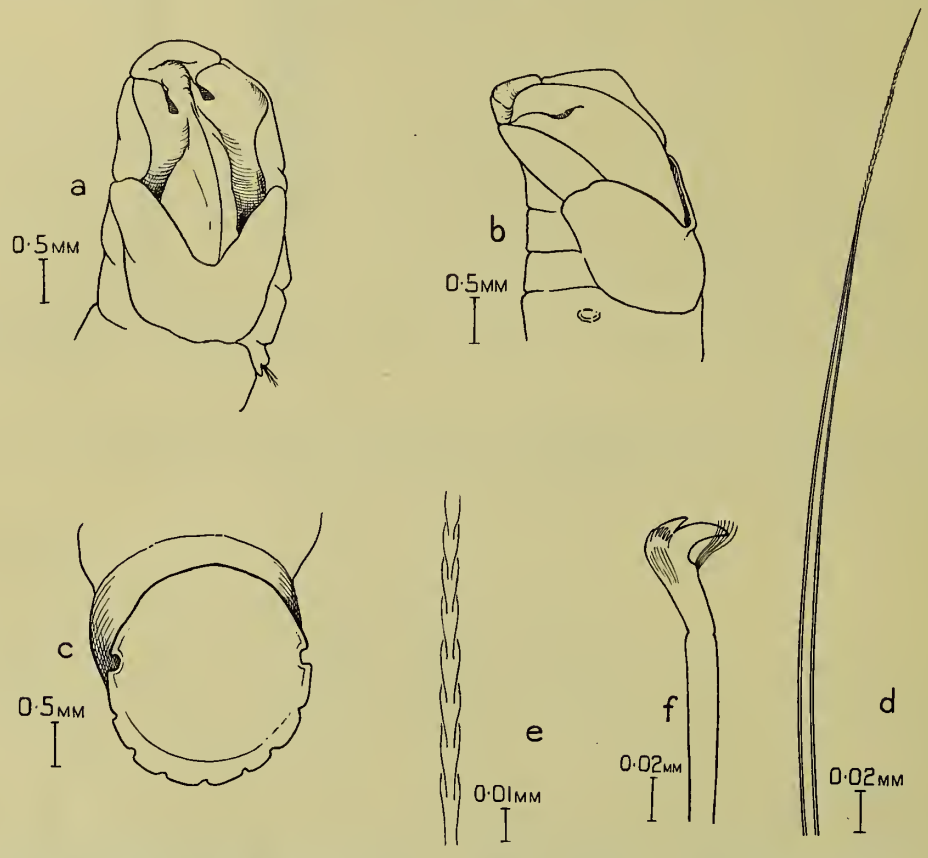
Treadwell, 1923, p. 9, figs. 5–8.

Occurrence :

St. 70, Gulf of Oman, 196 m. (2).

Distribution.—Lower California, Gulf of Oman.

Remarks.—A number of thick muddy tubes from which I have extracted two complete specimens in poor condition. The larger measures 62 mm. by 2 mm. There



Text-fig. 23.—*Maldane cristata* Treadwell. *a*, Head from above. *b*, Head from the side. *c*, Anal plate. *d*, Bilimbate dorsal bristle. *e*, Part of barbed dorsal bristle. *f*, Hook.

are 19 chætigers followed by 2 low rings which I take to represent 2 achætous anteanal segments. Cephalic plate oval (Text-fig. 23*a* and *b*), with a high keel running for about three-fourths of its length. The nuchal organs are short and curved ; they run parallel with the keel for about half their length, and then turn outwards at the sides of the crescentic palpode. There is a wide border divided into 3 quite smooth lobes by a pair of deep lateral incisions. The dorsal lobe of the border forms a deep hood at the back of the head. Ocelli are not visible.

There is no collar. Owing to the condition of the material the limits of the segments are indistinguishable. The buccal segment and first 3 chætigers are more or less uniformly

glandular. The 3rd chætiger shows also a narrow, prechætal, deeply staining, glandular band at the sides and underneath, but not on the dorsal surface. The 4th to the 7th chætigers show similar, but wider glandular bands. The 4th, 5th and 6th chætigers also show a pair of dorso-lateral glandular patches lying above and in front of the glandular bands.

The pygidium is as figured by Treadwell. It forms a flat plate (Text-fig 23*c*) at right angles to the main axis of the body. Its border has a pair of deep lateral incisions. Dorsally its edge is smooth, but ventrally below the lateral incisions the edge is cut up into a series of teeth more pronounced in these specimens than in Treadwell's figure. The dorsal bristles are of two kinds—bilimbate capillary bristles (Text-fig. 23*d*) with barbed tips, and long, very fine, delicate barbed bristles (Text-fig. 23*e*) The hooks (Text-fig. 23*f*) have in profile one tooth above the main fang, and above this a crown of fine denticles. The subrostral barbules curl over the tip of the main fang.

These specimens agree in the main with Treadwell's species described from an example obtained at a depth of 475 fms. off the coast of Lower California. I cannot, however, discover from Treadwell's account the shape of the nuchal organs, and the identification must remain uncertain. In the present specimens they are more curved than is usual in the genus. The species is characterized by the high keel, the deep cephalic pouch, and the denticulated ventral border of the anal plate. In the structure of the anal plate this species is close to *M. glebifex*, but the head is different. *Maldane gorgonensis* mihi is an allied species, but the keel is less convex and the border of the anal plate quite smooth.

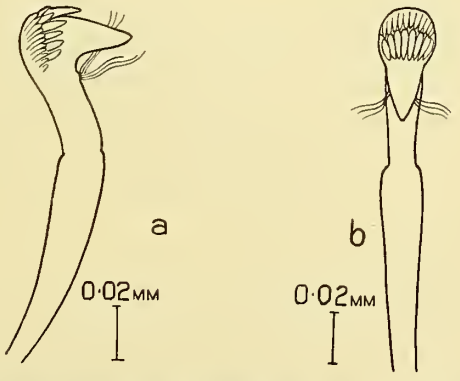
Maldane sarsi Malmgren var. *tropica* var. nov.

Occurrence :

St. 58, South Arabian Coast, 1189–1354 (3).

Distribution.—Arabian Coast.

Remarks.—From a number of thick muddy tubes I have succeeded in extracting three anterior and three posterior fragments. I have compared them with examples of the northern species, which Fauvel has also recorded from the Indian Ocean, and I see no ground for separation except that after staining with iodine green I can find no trace of the glandular crescent on the dorsal surface of the 5th chætiger which is constantly present in Malmgren's species. Moreover, the teeth in the row lying immediately above the main fang of the uncini (Text-fig. 24*a* and *b*) are smaller and more numerous. They are very



Text-fig. 24.—*Maldane sarsi* Malmgren var. *tropica* var. nov. *a*, Hook from the side. *b*, Hook from in front.

difficult to count, but I estimate 8 to 10. The subrostral barbules are more numerous and better developed than in the stem-form, and are formed in some uncini at any rate of two divergent bundles separated by the point of the main fang.

In other respects, in the form of the head and the anal plate, in the character of the bristles and in the arrangement of the glandular areas these specimens agree with *sarsi*.

Genus *Notoproctus* Arwidsson.

Notoproctus pacificus (Moore) ?

Lumbriclymene pacifica Moore, 1906, p. 246, pl. xii, figs. 40–42.
Notoproctus pacificus Arwidsson, 1922, p. 4, pl. i, figs. 1–4.

Occurrence :

St. 33, Gulf of Aden, 1295 m. (4).

Distribution.—Alaska, Vancouver Island, Gulf of Aden.

Remarks.—A number of very fine, separate, sandy tubes, from which I have extracted four small fragmentary specimens. They are quite colourless. Three are anterior fragments and there is one posterior. The largest measures 19 mm. by 0·5 mm. for 17 chætigers. They represent an exceedingly slender Maldanid and are in poor condition. The limits of the segments are impossible to determine.

The specimens may be young representatives of Moore's species. The head and hinder end, as far as can be made out, correspond to Arwidsson's figures, and there appear to be 2 posterior ridges marking the presence of 2 ante-anal achætous segments. Prechætal glandular girdles seem to be present in all somites. The bristles and hooks correspond closely to Moore's figures.

Moore's specimens were taken at a depth of 282 fms. in Chatham Strait, Alaska, Arwidsson's at a depth of 37 m. off Nanaimo, Vancouver Island, and the present specimens were obtained at a depth of nearly 1300 m.

Genus *Clymene* Savigny.

Clymene (*Praxillella*) *gracilis* (Sars) ?

Fauvel, 1927, p. 178, fig. 62 *m–p* ; and 1932, p. 201.

Occurrence :

St. 180, Gulf of Aden, 397 m. (1).

Distribution.—Atlantic, Mediterranean, Persian Gulf, Gulf of Aden.

Remarks.—An anterior fragment with 3 chætigers. The prostomium ends in a filiform tip, and as far as it goes the specimen agrees with Sars's species.

Clymene sp.

Occurrence :

St. 75, Gulf of Oman, 201 m. (2).

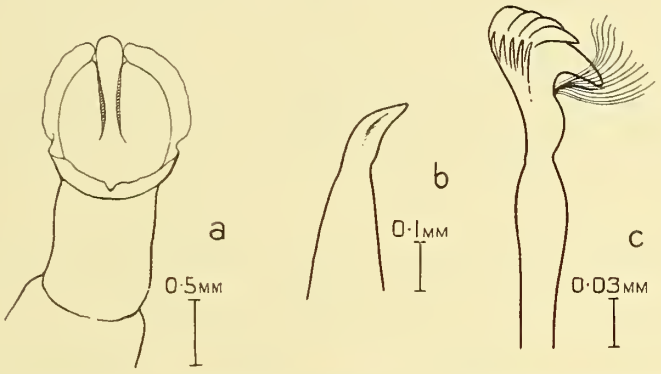
St. 141, Maldives, 44 m. (1).

St. 179B, Gulf of Aden, 275 m. (1).

Remarks.—The largest of these fragments has only 8 chætigers. There is no posterior end. On the head (Text-fig. 25*a*) the keel is narrow and long, occupying three-fourths of the length of the prostomium. The nuchal organs are long, straight, parallel.

The border is high and almost entire. There is a very slight incision in the mid-dorsal line and a pair of scarcely noticeable lateral notches. Ocelli are present. Pre-chætal glandular bands are present on the 5th to 8th chætigers.

The bristles are all simple bordered capillaries. The head of the anterior, ventral acicular hooks (Text-fig. 25*b*) is devoid of denticles and is at an acute angle to the shaft.



Text-fig. 25.—*Clymene* sp. *a*, Head from above. *b*, Anterior ventral hook. *c*, Hook.

The uncini (Text-fig. 25*c*) have rather numerous (4–5) denticles above the main fang. In the absence of a posterior region these specimens cannot be identified. The head with its very long, narrow keel and almost entire border is distinctive.

Genus *Clymenella* Verrill.

Clymenella sp.

Occurrence :

St. 105B, Zanzibar, 238–293 m. (1).

Remarks.—An anterior fragment of 8 chætigers measuring 28 mm. by 2 mm. The head is an oblique bordered plate with a low keel about two-thirds of the length of the prostomium. The nuchal organs are straight, and the border, which is higher at the sides than it is dorsally, is slightly notched at the sides and in the mid-dorsal line. The anterior border of the 4th chætiger forms a conspicuous, free collar of considerable width and even all round its edge. The feet are in the anterior part of the segment for the first 3 chætigers, and in the remainder are more or less in the middle. The first 3 chætigers show little glandular development. There is a narrow glandular band at the hinder edge of the 4th chætiger, and behind the 4th the prechætal parts of the segments form conspicuous glandular bands. All the bristles that I have seen are slender, bordered capillaries with delicate, elongate tips. The heads of the ventral acicular hooks of the first 3 chætigers turn over very little. The uncini have 4 teeth above the main fang and the usual subrostral barbules. In the absence of a hinder end this specimen cannot be given a specific attribution.

The genus *Clymenella* is in an unsatisfactory condition. It is somewhat loosely defined by Verrill (1900, p. 657), and Arwidsson (1906, pp. 207–209) subjects it to a critical discussion. Its type-species is *Clymenella torquata* (Leidy), of which there is a specimen in the Museum collection from Newport, Rhode Island, identified at, and presented by, the United States National Museum. It has uncini in the ventral rami of the first 3

chætigers, and not acicular hooks. In the 1st chætiger there is a row of 9 uncini, and the number is greater in the following segments. It also has a well-developed, free, membranous collar on the 4th chætiger, a conspicuous, anteanal raised ring and glandular bands in the 4th–8th chætigers. *Clymenella rubrocincta* Johnson has been redescribed by Arwidsson (1922, p. 29), and agrees in a general way with *torquata* except that there is no true collar on the 4th chætiger. I have examined several specimens from Friday Harbour, Washington, which formed part of the material on which Arwidsson's description was based, and I find a certain amount of telescoping of the hinder end of the first 3 chætigers into the anterior end of the segments that follow, especially at the junction between the 3rd and 4th chætigers, but no true collar. The number of uncini in the 1st chætiger is usually 6. The specimen from Coiba Island attributed by me (1933A, p. 1062) to *Clymene* (*Euclymene*) *rubrocincta* (Johnson) is misdetermined—a mistake due to a misapprehension of Johnson's description. Arwidsson (1916, p. 209) suggests that Johnson's *rubrocincta* should form the type of a new genus. I cannot see the necessity for this. *Clymenella* (*Axiothella*) *somersi* Verrill and *Clymenella elongata* Moore, the original description of which I have not been able to see, are, according to Arwidsson, close to *Axiothella catenata* Malmgren. Verrill's species has, in the anterior region, ventral uncini with " a large, sharp rostrate hook, directed somewhat upward and 3 (sometimes 4) small appressed apical hooks ". On the other hand, Arwidsson's *Clymenella minor* (1911, p. 24) has acicular hooks, not uncini, in the neuropods of the first 3 chætigers (the denticles shown in his figure of the anterior hooks in plate ii, fig. 44, are more pronounced than any I have seen), a relatively slightly developed collar on the 4th chætiger and a low pre-anal ring. Fauvel (1927, p. 182) regards *Clymenella* as differing from *Clymene* only by the presence of a collar on the 4th chætiger and refers Saint-Joseph's *Maldane cincta* to it. Augener has also described a *Clymenella* sp. from south-west Australia with ventral acicular hooks in the first three chætigers and a high collar on the 4th. Lastly there is the present specimen from the Indian Ocean.

We have, then, two groups of species under the name *Clymenella*, the *torquata*, *rubrocincta*, *somersi* and (?) *elongata* group, with anterior ventral *uncini* differing little, if at all, from their normal uncini, and the *minor*, *cincta* south-west Australian and Indian Ocean *Clymenella* sp. group, with anterior ventral *acicular hooks*. Both groups have a collar on the 4th chætiger in all species except *rubrocincta*, and in both groups this collar shows much variation in degree of development. Now the presence or absence of anterior ventral acicular hooks is generally used as a generic differential, and it is therefore unsatisfactory to find both groups under the same generic name. The alternative is either to separate the two groups by establishing one, if not two, new genera (if Arwidsson's view of *rubrocincta* be adopted), or to treat the presence of a collar, raised preanal ring and the other characters enumerated by Arwidsson (1906, p. 209) as specific characters, to abandon the genus *Clymenella* altogether, and to refer the group of species with anterior ventral uncini to *Axiothella* and the group with anterior ventral acicular hooks to *Clymene* sensu Fauvel (1927, p. 170). Moreover, the former group would, I believe, be capable of inclusion within *Axiothella*, as defined by Fauvel (1927, p. 183) if the words " pas de collerette " were omitted. Saint-Joseph (1894, p. 131) in his classification of the Maldanids refuses to accept the presence of a collar on the 4th chætiger as a generic character. This procedure would at least have the merit of economy, and the grouping would be more natural than the one obtaining at present.

Genus *Nicomache* Malmgren.

Nicomache sp.

Occurrence :

St. 104, Zanzibar, 207 m. (5).

St. 106, Zanzibar, 183–194 m. (1).

St. 126, Zanzibar, 209 m. (1).

Remarks.—These are all anterior fragments, and in the absence of a posterior region incapable of even generic attribution with any certainty. They seem, as far as they go, to be close to *N. maculata* Arwidsson. The reddish-brown spots on the anterior end and the bristles, hooks, etc., are very like those described for that species.

Genus *Petaloproctus* Quatrefages.

Petaloproctus cirratus n. sp.

Occurrence :

St. 54, South Arabian Coast, 1046 m. (4).

Distribution.—Arabian Coast.

Description.—A small mass of brittle sandy tubes incrusting a Polyzoan yielded a number of anterior and posterior fragments. The largest measures 29 mm. by 2 mm. for 13 chætigers. The anterior and posterior regions are moderately well preserved, but the middle region is torn and macerated. There is no colour. The head and buccal segment (Text-fig. 26*a*) are together shorter than the first chætiger. The first 3 chætigers are about twice as long as the 4th, 5th and 6th, and at the 7th the segments lengthen out again. There is a certain amount of telescoping of the hinder end of the segments into the front end of those that follow in the 2nd to the 5th chætigers. This is most marked at the 4th chætiger, which has a kind of thick collar in front. It is not, however, a true collar with a free margin. Glandular rings are apparently present in all chætigers. They are prechætal anteriorly, and on a level with the feet in the hinder region.

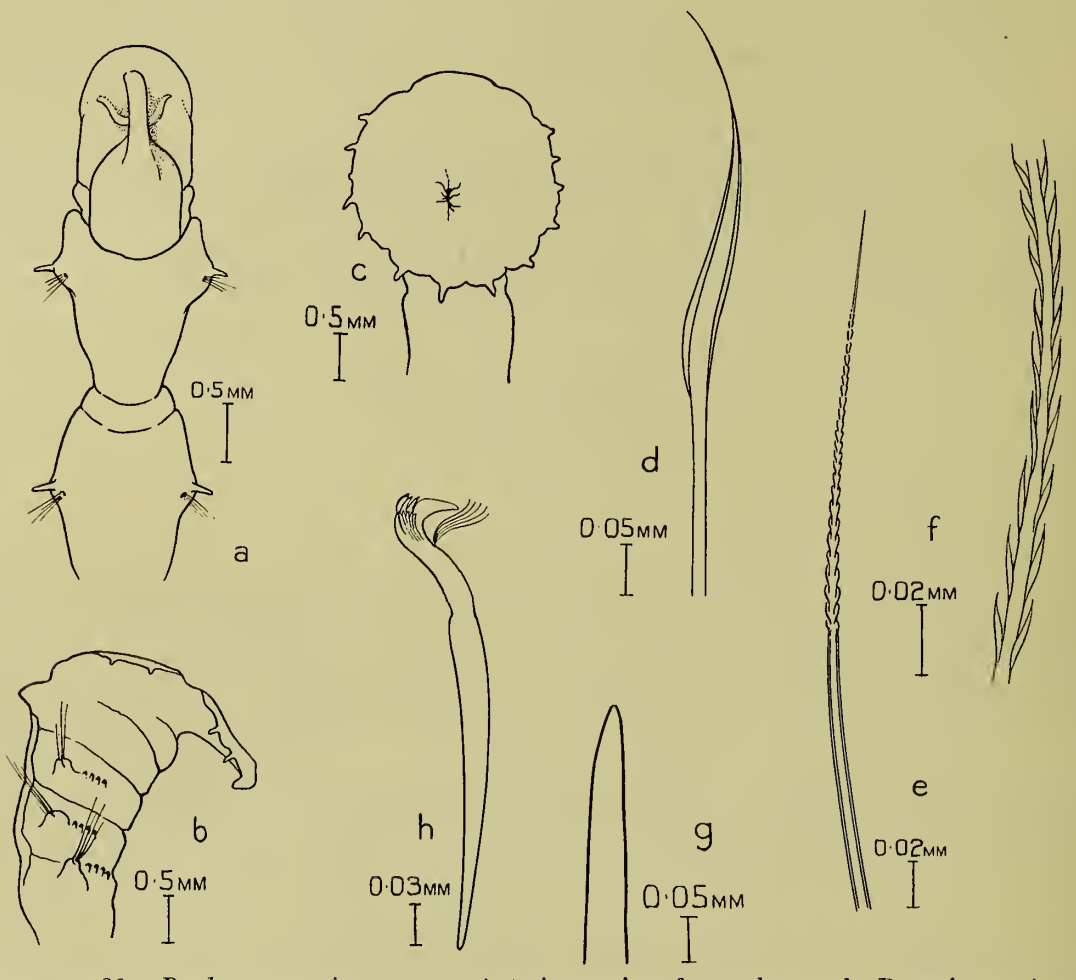
The cephalic plate is very oblique : it is rounded in front, has a prominent keel running up most of its length and a pair of divergent, slightly curved nuchal organs. There is no border. The buccal segment which is dorsally not separated from the head, is very short, being only about one-fourth of the length of the first chætiger. The last chætiger, which carries both bristles and hooks, is followed by 2 low rings, the second of which is incomplete dorsally ; they presumably represent 2 achætous ante-anal segments (Text-fig. 26*b*).

The anal plate (Text-fig. 26*c*) is large and lies at an angle of about 45° to the body. It has a wide border, which disappears dorsally. This border carries about 15 short cirriform processes at intervals along its edge. The pleated anus lies a little below the median line.

The bristles are of three kinds : (1) smooth bristles with wide borders and a long tip (Text-fig. 26*d*) ; (2) narrowly bordered bristles (Text-fig. 26*e*), smooth proximally but with barbed tips ; (3) long, very delicate barbed bristles (Text-fig. 26*f*). The acicular ventral hooks (Text-fig. 26*g*) of the first 3 chætigers are straight and have obtuse tips. The uncini (Text-fig. 26*h*) are as figured. In profile there are 2 principal teeth

above the main fang and these have a cap of denticles. The subrostral barbules are very long.

The description of this species can only be completed on better material. The anal



TEXT-FIG. 26.—*Petaloproctus cirratus*. *a*, Anterior region from above. *b*, Posterior region from the side. *c*, Anal plate. *d*, Smooth bordered bristle. *e*, Bilimbate bristle. *f*, Part of barbed bristle. *g*, Anterior acicular ventral hook. *h*, Hook.

plate with its cirri is unlike that of any other member of the genus. It appears to be most nearly allied to *P. crenatus* Chamberlin, which has, however, no achætous ante-anals and no uncini on the last chætiger.

Family OWENIIDÆ.

Genus *Owenia* Delle Chiaje.

Owenia fusiformis Delle Chiaje.

Fauvel, 1927, p. 203, fig. 71 *a–f*; and 1932, p. 208, with citations.

OCCURRENCE :

St. M.B. Ib, Red Sea, 29 m. (1).

DISTRIBUTION.—Atlantic, Mediterranean, Indian Ocean, Pacific.

REMARKS.—A single specimen and several fragments of tubes. The imbrication of the particles with which the tube is coated is less obvious than usual.

Family Sabellariidæ.

Genus *Sabellaria* Lamarck.

Sabellaria spinulosa Leuckart.

Fauvel, 1927, p. 208, fig. 73 *a–p* ; and 1932, p. 209.

Occurrence :

St. 45, South Arabian Coast, 38 m. (2).

Distribution.—Atlantic, Indian Ocean, Pacific.

Sabellaria spinulosa Leuckart var. *alcocki* Gravier.

Fauvel, 1927, p. 211 ; and 1932 , p. 209.
Sabellaria alcocki Gravier, 1909, p. 298, pl. viii, figs. 11–23.

Occurrence :

St. 27, Gulf of Aden, 37–91 m. (1).

Distribution.—Atlantic, Indian Ocean, Persian Gulf.

Remarks.—A single specimen measuring 9 mm. by 1 mm. without the tail. I am not quite satisfied as to its identity. The long erect middle paleæ (Text-fig. 27) are apparently smooth, and have much less basal excavation than that figured by Gravier. They are more like those figured by Augener (1918, pl. vii, figs. 187–190) for his *S. eupomatoides*. On the other hand, the inner paleæ are more slender and elongate than in Augener's figure (*loc. cit.*, fig. 190), and resemble that given by Gravier for his *alcocki*.

Text-fig. 27.—*Sabellaria spinulosa* Leuckart var. *alcocki* Gravier. Middle palea.

Family Ampharetidæ.

Genus *Amphicteis* Grube.

Amphicteis gunneri Sars.

Fauvel, 1927, p. 231, fig. 80 *a–k* ; and 1932, p. 216.

Occurrence :

St. 178, Gulf of Aden, 91 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Japan.

Remarks.—A single specimen in poor condition. With Fauvel I am unable to distinguish the tropical from the northern form.

Family Terebellidæ.

Genus *Thelepus* Leuckart.

Thelepus comatus (Grube).

Hessle, 1917, p. 216, pl. iii, figs. 5–7, text-fig. 62.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—Chile, Panama, Arabian Coast.

Remarks.—The specimen is in very poor condition. The posterior end is missing and it has about 29 chætigers, of which the first 26 carry bristles. In the hinder segments the hooks are arranged in loops exactly as figured by Hessle. The presence of eye-spots is queried by Hessle. In this specimen they are numerous and conspicuous.

Genus *Nicolea* Malmgren.

Nicolea gracilibranchis (Grube).

Fauvel, 1932, p. 225, with citations.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—Philippines, Indian Ocean, Arabian Coast.

Remarks.—A single macerated specimen with very long, sparsely branched branchiæ.

Genus *Polymnia* Malmgren.

Polymnia nebulosa (Montagu).

Fauvel, 1927, p. 257, fig. 89 *a–g* ; and 1932, p. 224.

Occurrence :

St. 27, Gulf of Aden, 37–91 m. (1).

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Pacific.

Remarks.—These specimens are in fairly good condition, and with Fauvel I do not find the tropical form separable from the European species.

Genus *Loimia* Malmgren.

Loimia medusa Savigny.

Fauvel, 1932, p. 224, with citations.

Occurrence :

St. M.B. Ib, Red Sea, 26 m. (1).

St. 45, South Arabian Coast, 38 m. (1).

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Atlantic, Indian Ocean, Pacific.

Genus *Pista* Malmgren.

Pista herpini Fauvel.

Fauvel, 1930, p. 57, fig. 16, *a–h* ; and 1932, p. 230.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—Gulf of Manaar, Persian Gulf, Arabian Coast.

Remarks.—This is a very small specimen, measuring only 7 mm. in length by 1 mm. at the widest part. The branchiæ have a rather long, simple stalk and a densely branched apex. The specimen appears to be a young example of this species.

Pista typha (Grube).

Fauvel, 1932, p. 226, fig. 36 *a–c*, with citations.

Occurrence :

St. M.B. Id, Red Sea, 26 m. (1).

St. 206, Red Sea, 256 m. (1).

Distribution.—Philippines, Indian Ocean, Japan, Australia.

Remarks.—In this species the gills with the whorled tufts are easily recognizable. As Fauvel has pointed out, it seems very close to the European *P. cristata* Müller.

Pista robustiseta Caullery.

Fauvel, 1932, p. 227, fig. 37 *a–e*.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—Malay, Gulf of Oman, Japan, Arabian Coast.

Remarks.—A single damaged specimen, which as far as it goes corresponds closely to the accounts of this species.

Family Sabellidæ.

Genus *Demonax* Kinberg (*char. emend.* Johansson).

Demonax leucaspis Kinberg.

Monro, 1933a, p. 1075, with synonymy.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

Distribution.—Callao, Valparaiso, Honolulu, Japan, California, Panama, Arabian Coast.

Remarks.—A single specimen in poor condition. I have compared it with some examples from Balboa attributed by me to this species and I find them conspecific.

Genus *Dasychone* Sars.

Dasychone cingulata Grube.

Fauvel, 1932, p. 236, with citations.

Occurrence :

St. 53, South Arabian Coast, 13·5 m. (5).

Distribution.—Red Sea, Persian Gulf, Indian Ocean, Pacific.

Remarks.—The diffuse dark spots over the body are very characteristic of this species.

Genus *Branchiomma* Kölliker.

Branchiomma mushaensis Gravier.

Gravier, 1908, p. 94, pl. vii, figs. 267–270, and text-figs. 447–453.
Monro, 1933a, p. 1078, with synonymy.

Occurrence :

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Red Sea, California, Galapagos, Arabian coast.

Remarks.—The gills have broad, purplish-brown bands extending on to the rachises.

Genus *Euratella* Chamberlin.

Euratella puncturata (Augener).

Demonax puncturatus Augener, 1918, p. 576, pl. vi, figs. 170, 171, text-fig. 102.
Euratella puncturata Monro, 1930, p. 203.

Occurrence :

St. M.B. IIc, South Arabian Coast, 29 m. (2).

Distribution.—West Africa, Annobón, Ascension Island, Arabian coast.

Remarks.—I have compared these specimens with the examples from Ascension Island attributed by me to this species, and except that they have 7 instead of 5 thoracic chætigers they agree closely. The material does not permit me to add anything to the previous accounts.

Family Serpulidæ.

Genus *Serpula* L.

Serpula vermicularis L.

Fauvel, 1927, p. 351, fig. 120 *a–q* ; and 1932, p. 241.

Occurrence :

St. 45, South Arabian Coast, 38 m. (4).

St. 53, South Arabian Coast, 13·5 m. (2).

Distribution.—Atlantic, Mediterranean, Indian Ocean, Pacific.

Genus *Hydroides* Gunnerus.

Hydroides exaltata (Marenzeller) var. *vesiculosa* Fauvel.

Fauvel, 1923a, p. 137, fig. 7.

Occurrence :

St. 112, Zanzibar, 113 m. (2).

Distribution.—Gambier Islands, Zanzibar.

Remarks.—Two small specimens with opercula corresponding closely to that described by Fauvel. A large hollow vesicle takes the place of the great unpaired hook exactly as described by him. There is, however, one small point of difference. In the present specimens there appears to be a tendency towards the development of rudimentary lateral processes at the tips of the teeth of both cups, the upper and the lower—a tendency not apparent in Fauvel's specimen. I believe the only other record of this variety to be from the Gambier Islands.

Hydroides homoceros Pixell.

Pixell, 1913, p. 74, pl. 8, fig. 1.

Occurrence :

St. 53, South Arabian Coast, 13·5 m. (2).

Distribution.—Maldives, Zanzibar, Arabian Coast.

Remarks.—Two small specimens with tubes. The opercula correspond exactly to Pixell's description and figure.

Genus *Spirobranchus* Blainville.

Spirobranchus giganteus Pallas.

Fauvel, 1932, p. 244, with citations.

Occurrence :

St. 45, South Arabian Coast, 38 m. (2).

St. 53, South Arabian Coast, 13·5 m. (1).

Distribution.—Atlantic, Indian Ocean, Pacific.

Remarks.—These specimens have 4 opercular horns, except one from St. 45, which has 5. The specimens from St. 45 are young, the larger measuring about 12 mm. in length.

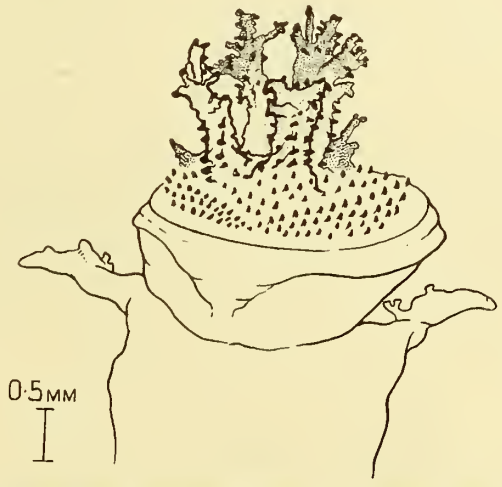
Spirobranchus giganteus Pallas var. *arabica* var nov.

Occurrence :

St. 45, South Arabian Coast, 38 m. (6).

Distribution.—South Arabian Coast.

Remarks.—These specimens show a type of opercular variation so unusual that it merits a varietal name. The opercular calcareous plate is beset with small chitinous



Text-fig. 28.—*Spirobranchus giganteus* Pallas var. *arabica* var. nov. Operculum.

spines, which are also present on the horns (Text-fig. 28). Moreover, there is a tendency for the production of ramifying chitinous outgrowths, some growing directly from the surface of the calcareous plate and others from the distal end of the horns, so that in some cases the latter have a basal calcareous region beset with spines and a distal chitinous region. The specimens have a measurement of about 35 mm. in length by 3 mm. across the thorax and the tubes are bright pink in colour.

A similar development of horny spines on the opercular plate is found in Fauvel's *Pomatostegus polytrema* var. *indica*.

Spirobranchus maldivensis Pixell.

Pixell, 1913, p. 84, pl. 9, fig. 9.
Fauvel, 1932, p. 245.

Occurrence :

St. 53, South Arabian Coast, 13·5 m. (1).

St. 71, Gulf of Oman, 106 m. (4).

St. 72, Gulf of Oman, 73 m. (2).

Distribution.—Maldives, Burma, Arabian Coast, Gulf of Oman.

Remarks.—The specimens from St. 72 were obtained from off a Muricid shell. Of those from St. 71, one has an operculum surmounted by two distinct calcareous plates and recalls *Spirobranchus latiscapus* (Marenzeller), from which, as I have already suggested (1936, p. 192), the present species is very doubtfully separable. Another has a thick cluster of hydroids growing from its opercular plate, and a third has its operculum crowned with an empty spirorbid tube.

Genus *Vermiliopsis* Saint-Joseph.

Vermiliopsis glandigera Gravier.

Gravier, 1908, p. 121, pl. viii, figs. 290, 291, text-figs. 476–481.
Monro, 1930, p. 209, fig. 88 *a–c*.
Fauvel, 1930, p. 63.

Occurrence :

St. 43, South Arabian Coast, 83–100 m. (1).

Distribution.—West Africa, Red Sea, Panama, Arabian Coast.

Remarks.—The horny opercular cap has numerous partitions and tapers more or less to a point as in *V. infundibulum*. There are two small and rather worn fragments of tube which show about 5 longitudinal ridges, only one of which appears to be denticulated. As far as can be seen from the very scanty material the tube resembles that of *V. agglutinata* (Marenzeller).

Vermiliopsis acanthophora Augener.

Augener, 1914, p. 155, pl. l, figs. 21–24, text-fig. 19.
Fauvel, 1930, p. 63.

Occurrence :

St. 45, South Arabian Coast, 38 m. (1).

St. 66, Gulf of Oman, 609 m. (6).

St. 89, North Arabian Sea, 135–183 m. (6).

Distribution.—Australia, Gulf of Manaar, Galapagos, Gulf of Oman, Arabian Coast.

Remarks.—This appears to be a common species. The tubes show the marks of successive peristomes but are devoid of longitudinal ridges. In some specimens the horny top of the operculum is broken off, which gives them a misleading appearance.

Vermiliopsis multicristata (Philippi) ?

Fauvel, 1927, p. 365, fig. 125 *k–s*.

Occurrence :

St. 112, Zanzibar, 113 m. (1).

Distribution.—Atlantic, Mediterranean, Zanzibar ?

Remarks.—A single specimen with some fragments of tube was obtained from off a Cidarid spine. The operculum has a long, tapering, conical, much-divided cap exactly like that of *V. infundibulum*. The tubes, on the other hand, show about 5 clearly denticulated longitudinal ridges similar to those of the Mediterranean form. As far as I know, this species has never been recorded from the Indian Ocean.

Genus *Placostegus* Philippi.

Placostegus tridentatus (Fabricius).

Fauvel, 1927, p. 373, fig. 128 *h–p* ; and 1933, p. 79.

Occurrence :

St. 112, Zanzibar, 113 m. (1).

Distribution.—Atlantic, Mediterranean, Zanzibar.

Remarks.—I obtained from off a Cidarid spine a small section of semi-transparent, crystalline tube twisted upon itself and with 3 spines at the mouth. It is characteristic of the present species and contained an ill-preserved specimen, which as far as can be seen agrees with the European form. I was unable to see the girdle of eyes and the abdominal bristles, but in other respects, in the shape of the operculum, the absence of collar bristles and the form of the thoracic chætæ and hooks it shows no ground for separation. Except for a single doubtful record by Fauvel from the Gulf of Suez this species has not previously been signalled from the Indian Ocean.

Genus *Ditrupa* Berkeley.

Ditrupa arietina (O. F. Müller).

Fauvel, 1927, p. 374, fig. 128 *a–g* ; and 1932, p. 247.

Occurrence :

St. M.B. Id, Red Sea, 26 m. (1).

St. 45, South Arabian Coast, 38 m. (1).

St. 176, Gulf of Aden, 655–732 m. (numerous dry tubes).

Distribution.—Atlantic, Mediterranean, Indian Ocean.

Remarks.—The dry tubes from the deep water St. 176 show slight but discernible traces of the regular annular enlargements described by Fauvel (1932, p. 247) for his var. *monilifera*.

REFERENCES.

Arwidsson, J. 1899. Studien über die Familien Glyceridæ und Goniadidæ. Bergens Mus. Aarb. XI, 1898, 70 pp., 4 pls.

—— 1906. Studien über die skandinavischen und arktischen Maldaniden. Inaugural Dissertation, Uppsala ; also Zool. Jb. Jena. Abt. f. Syst. Suppl. IX (1), 308 pp., 12 pls.

—— 1911. Die Maldaniden. Wiss. Ergebn. Schwed. Südpolar-Exped., 1901–3, VI (6), Stockholm, 44 pp., 2 pls.

—— 1922. Systematic Notes on Some Maldanids. K. Svenska Vetensk-Akad. Handl. Stockholm, LXIII (7), 46 pp., 2 pls., 16 text-figs.

Augener, H. 1913. Polychæta : I. Errantia. Michaelsen, W., und Hartmeyer, R. Die Fauna Südwest-Austr. IV, pp. 63–304, pls. ii and iii, 42 text-figs.

—— 1914. Polychæta : II. Sedentaria. Michaelsen, W., und Hartmeyer, R. Die Fauna Südwest-Austr. V, pp. 1–170, pl. 1, 19 text-figs.

—— 1918. Polychæta. Beitr. Meeresfauna West-Afr. Herausgeg. v. W. Michaelsen, II (2), pp. 67–625, pls. 2–7, Hamburg.

—— 1924. Polychæta : II. Polychæten von Neuseeland : I. Errantia. Vidensk. Medd. Naturh. Foren. Kbh. LXXV, pp. 241–441, 11 text-figs.

—— 1927. Polychæten von Südost- und Süd-Australien. Videns. Medd. Naturh. Foren. Kbh. LXXXIII, pp. 71–275, 17 text-figs.

—— 1932. Antarktische und antiboreale Polychæten nebst einer Hirudinee. Sci. Res. Norweg. Antarctic Exped. 1927–9, No. 9, Norsk. Videns.-Ak., Oslo, 85 pp., 1 pl.

Baird, W. 1868. A Monograph of the Amphinomacea. J. Linn. Soc. (Zool.) London, pp. 215–246, pls. iv–vi.

Chamberlin, R. V. 1919. " Albatross " Polychæta. Mem. Harv. Mus. Comp. Zöol. XLVIII, pp. 514, 80 pls.

Claparède, A. R. E. 1863. Beobachtungen über Anatomie und Entwicklungsgeschichte wirbelloser Thiere, Leipzig, 120 pp., 18 pls.

—— 1870. Les Annélides Chétopodes du Golfe de Naples (Supplement). Mém. Soc. Phys. Geneva, XX, pp. 365–542, 14 pls.

Crossland, C. 1903. On the Marine Fauna of Zanzibar and British East Africa, from Collections made by Cyril Crossland in the years 1901 and 1902. Polychæta : Part II. Proc. Zool. Soc. London, II, pp. 129–144, pls. xiv and xv ; and 1904, Part III, *op. cit.*, I, pp. 287–330, pls. xx–xxii.

—— 1924. Polychæta of Tropical East Africa, the Red Sea and Cape Verde Islands collected by Cyril Crossland and of the Maldive Archipelago collected by Professor Stanley Gardiner, M.A., F.R.S. : The Lumbriconereidæ and Staurocephalidæ. Proc. Zool. Soc. London, I, 106 pp., 125 text-figs.

Ehlers, E. 1901. Die Polychæten des magellanischen und chilenischen Strandes. Fests. Ges. Wiss. Göttingen, 232 pp., 25 pls.

—— 1904. Neuseeländische Anneliden. Abh. Ges. Wiss. Göttingen, III, 70 pp., 9 pls.

—— 1908. Die bodensässigen Anneliden aus den Sammlungen der deutschen Tiefsee-Expedition. Wiss. Ergebn. " Valdivia ", XVI (1), 167 pp., 23 pls.

—— 1913. Die Polychæten-Sammlungen der deutschen Südpolar-Expedition, 1901–3. Dtsch. Südpolar-Exped. XIII (4), pp. 397–598, 21 pls.

Fauvel, P. 1911. Annélides Polychètes du Golfe Persique. Arch. Zool. exp. gén. VI, pp. 353–439, pls. xix–xxi.

—— 1917. Annélides Polychètes de l'Australie méridionale. Arch. Zool. exp. gén. LVI, pp. 159–278, pls. iv–viii.

—— 1919. Annélides Polychètes de Madagascar, de Djibouti et du Golfe Persique. Arch. Zool. exp. gén. LVIII, pp. 315–473, pls. xv–xvii, 12 text-figs.

—— 1923. Polychètes errantes. Faune Fr. V, 488 pp., 181 figs.

—— 1923a. Annélides Polychètes des Iles Gambier et de la Guyane. Mem. Accad. Nuovi Lincei Roma, ser. 2, VI, pp. 89–147, 8 text-figs.

—— 1925. Sur quelques espèces du genre Aphrodite. Bull. Soc. Zool. Fr. L, pp. 131–150, 5 text-figs.

—— 1927. Polychètes sédentaires. Faune Fr., Paris, XVI, 494 pp., 152 figs.

—— 1930. Supplement to the Littoral Fauna of Krusadai Island in the Gulf of Manaar : Annelida Polychæta. Bull. Madras Govt. Mus., new series, Nat. Hist. Section, I (2), I, 72 pp., 18 text-figs.

—— 1932. Annelida Polychæta of the Indian Museum, Calcutta. Mem. Indian Mus. XII (1), 262 pp., 9 pls., 18 text-figs.

Fauvel, P. 1933. Mission Robert Ph. Dollfus en Égypte : Annélides Polychètes. Mém. Inst. Égypte, XXI, pp. 31–83, 4 text-figs.

—— 1935. Annélides Polychètes de l'Annam. Mem. Accad. Nuovi Lincei, Roma, ser. 3, II, pp. 279–354, 8 text-figs.

Gravier, C. 1900. Contribution à l'étude des Annélides Polychètes de la Mer Rouge. Nouv. Arch. Mus. Hist. Nat. Paris (4), II, pp. 137–282, pls. ix–xiv ; and 1901, *op. cit.* (4), III, pp. 147–268, pls. vii–x ; and 1908, *op. cit.* (4), X, pp. 67–168, figs. 410–495.

—— 1909. Contribution à l'étude de la morphologie et de l'évolution des Sabellariens Saint-Joseph. Ann. Sci. Nat. (9), IX, pp. 287–307, pls. vii, viii.

Grube, E. 1877. Anneliden-Ausbeute S.M.S. " Gazelle ". Mber. Preuss. Akad. Wiss. Berlin, pp. 509–554.

—— 1878. Annulata Semperiana-Beiträge zur Kenntniss der Anneliden Fauna der Philippinen. Mém. Acad. sci. St. Pétersb. (7), XXV, No. 8, ix, 300 pp., 15 pls.

Hessle, C. 1917. Zur Kenntniss der terebellomorphen Polychæten. Zool. Bidr. Uppsala, V, pp. 39–258, 5 pls., 66 text-figs.

Holly, M. 1935. Polychæta from Hawaii. Bishop Mus. Bull. CXXIX, 33 pp., 1 pl., 15 text-figs.

Horst, R. 1912. Polychæta errantia. " Siboga " Exped. Mon. XXIVa, 43 pp., 10 pls. ; and 1917, *op. cit.*, XXIVb, 140 pp., 18 pls.

Johnson, H. P. 1897. A Preliminary Account of the Marine Annelids of the Pacific Coast, with Descriptions of New Species. Proc. Calif. Acad. Sci. III, Zool. I, pp. 153–190, pls. v–x.

McIntosh, W. C. 1885. Report on the Annelida Polychæta collected by H.M.S. " Challenger " during the years 1873–6. " Challenger " Rep. Zool. XII, 554 pp., 94 pls.

—— 1894. A Contribution to Our Knowledge of the Annelida. Quart. J. Micr. Sci. XXXVI, pp. 53–76, pls. vi–viii.

Michaelsen, W. 1892. Polychæten von Ceylon. Jb. Hamburg wiss. Anst. IX (2), pp. 91–113, 1 pl.

Monro, C. C. A. 1924. On the Polychæta collected by H.M.S. " Alert ", 1881–2 : Families Polynoidæ, Sigalionidæ and Eunicidæ. J. Linn. Soc. London, Zool. XXXVI, pp. 37–77, 24 text-figs.

—— 1930. Polychæte Worms. " Discovery " Rep. II, 222 pp., 91 text-figs.

—— 1931. On a Collection of Polychæta in the Raffles Museum, Singapore. Bull. Raffles Mus., Singapore, V, pp. 33–46, 4 text-figs.

—— 1933. The Polychæta Errantia collected by Dr. C. Crossland at Colon, in the Panama Region and the Galapagos Islands during the Expedition of the S.Y. " St. George ". Proc. Zool. Soc. London, I, pp. 1–96, 36 text-figs.

—— 1933a. The Polychæta Sedentaria collected by Dr. C. Crossland at Colon, in the Panama Region and the Galapagos Islands during the Expedition of the S.Y. " St. George ". Proc. Zool. Soc. London, IV, pp. 1039–1092, 31 text-figs.

—— 1934. A Collection of Polychæta from the Coast of China. Ann. Mag. Nat. Hist., ser. 10, XIII, pp. 353–80, 10 text-figs.

—— 1936. Polychæte Worms, II. " Discovery " Rep. XII, pp. 59–198, 34 text-figs.

—— 1936a. On the Heteronereid of *Platynereis pulchella* Gravier, A Polychæte belonging to the Family Nereidæ : A Preliminary Note. Ann. Mag. Nat. Hist., ser. 10, XVIII, pp. 380–384, 3 text-figs.

Moore, J. P. 1906. Additional New Species from the North Pacific. Proc. Acad. Nat. Sci. Philad., LVIII, pp. 217–260, pls. x–xii.

Pixell, H. L. M. 1913. Polychæta of the Indian Ocean : Serpulidæ. Trans. Linn. Soc. London, Zool. XVI, pp. 69–92, pls. viii–ix.

Potts, F. A. 1910. Polychæta of the Indian Ocean : II. Trans. Linn. Soc. London (2), Zool. XIII, pp. 325–353, pls. xviii–xxi.

Rosa, D. 1908. Annelidi. I : Tomopteridi. Raccolte Planctoniche f. d. R.N. " Liguria " (1), V, pp. 247–326, pl. 12. Pubbl. Ist. St. sup. Firenze.

Saint-Joseph, Baron de. 1894. Les Annélides Polychètes des côtes de Dinard : III. Ann. Sci. Nat. (7), XVII, 395 pp., 13 pls.

Treadwell, A. L. 1923. Polychætous Annelids from Lower California with Descriptions of New Species. Amer. Mus. Novit. LXXIV, 11 pp., 8 figs.

Verrill, A. E. 1900. Turbellaria, Nemertina and Annelida of the Bermudas. Trans. Conn. Acad. Arts Sci. X, pp. 593–670.

Willey, A. 1905. Report on the Polychæta Collected by Prof. Herdman at Ceylon, 1902. Roy. Soc. Rep. on Pearl Oyster Fisheries. Suppl. Rep. XXX, London, pp. 243–324, pls. 1–8.

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INTRODUCTION

The collection consists of 1160 specimens, of which 101 are small forms which it has not been possible to name. The remaining 1059 fall into 36 genera, of which one is believed to be new, and 53 species and subspecies, of which 18 are believed to be new. The majority of the previously known species have been described by one of three authors : Alcock (1893) and Koehler (1909), both of whom have reported on the collections made by the R.I.M.S. " Investigator ", and Fisher (1919), whose report on ' The Starfishes of Philippine Seas and Adjacent Waters ' is particularly valuable. The arrangement and classification put forward by Fisher (1911 *et seq.*) has been followed in the present report.

The colours of a certain number of specimens were matched with those given in ' Color Standards and Color Nomenclature ' by Ridgway (1912), as soon as possible after capture. When mentioned in the text, colours refer to this work unless the contrary is stated.

Details believed to be of systematic importance are illustrated in the text-figures, which are by the author. Each has been drawn under a *camera lucida*, but is presented somewhat diagrammatically. Spines, which in life stand erect, are usually shown lying in the same plane as the plate that bears them. For the plates I am greatly indebted to Mr. J. Henderson of the Zoological Laboratory, Cambridge.

A glossary of terms used in starfish nomenclature is given by Fisher (1906, p. 1118). The following abbreviations are used in this paper :

Abact. . .	abactinal.
SMP. . .	supero-marginal plate.
IMP. . .	infero-marginal plate.
TP. . .	terminal plate.
Act. int. .	actinal intermediate (or interradial).
Adamb. . .	adambulacral.
Adamb. Act. .	actinal surface of adambulacral plate.
Adamb. Fur. .	furrow spines.

I would like to take this opportunity of extending my sincerest thanks to Dr. Baini Prashad, Superintendent and Honorary Director of the Zoological Survey of India, who very kindly sent to Cambridge for comparison some types and other material from the collections under his care ; and to Mr. D. Dilwyn John, who has devoted much time and trouble to the correction and revision of the manuscript.

LIST OF SPECIES COLLECTED BY THE EXPEDITION

Species.	Stations at which obtained.	Total number obtained.	Depth in metres.	Locality.
Eremicaster tenebrarius (Fisher)	171	24	3840–3872	African coast.
Hyphalaster tara Alcock & Wood-Mason	171	15	3840–3872	,, ,,
H. giganteus sp. n.	171	1	3840–3872	,, ,,
Pectinidiscus annæ Ludwig	104, 106, 110	41	207–384	Zanzibar.
Astropecten polyacanthus Müller & Troschel	27, 146	106	37–91	Gulf of Aden, Maldives.
A. griegi Koehler	143, 145	13	494–797	,,
A. pusillulus Fisher	153	2	256–293	,,
A. monacanthus Sladen	80	3	16–22	Arabian Sea.
Persephonaster cingulatus (Fisher)	118, 185	2	1789–2000	Zanzibar, Gulf of Aden.
P. sewelli sp. n.	105, 110, 115, 123	9	238–658	Zanzibar.
P. gracilis (Sladen)	81, 120, 171	3	2926–3872	Arabian Sea, Zanzibar, African coast.
Dipsacaster farquharsoni sp. n.	157	1	229	Maldives.
Luidia prionota Fisher	A	2	65–68	Gulf of Suez.
L. avicularia Fisher	27	1	37–91	Gulf of Aden.
Pectinaster agassizii (Ludwig)	185	2	2000	,, ,,
P. agassizii granuliferus subsp. n.	26	3	2312	,, ,,
Benthopecten heteracanthus sp. n.	26	1	2312	,, ,,
Pseudarchaster mozaicus Alcock & Wood-Mason	108, 115, 122	4	640–786	Zanzibar.
P. diversigranulatus sp. n.	26, 59	3	1948–2312	Gulf of Aden, Arabian Sea.
Paragonaster stenostichus Fisher	105, 110	2	238–384	Zanzibar.
P. ctenipes breviradiatus subsp. n.	105, 106,	63	183–293	,,
	153	1	256–293	Maldives.
Rosaster cassidatus sp. n.	153, 157	58	229–293	,,
Mediaster ornatus Fisher	159	1	914–1463	,,
M. murrayi sp. n.	107, 109, 123	57	256–640	Zanzibar.

Species.	Stations at which obtained.	Total number obtained.	Depth in metres.	Locality.
Nymphaster moebii (Studer)	105, 108, 109, 110, 115, 122	55	238–786	Zanzibar.
	143, 145	11	494–797	Maldives.
	184	6	1270	Gulf of Aden.
Eugoniaster ephemeralis sp. n.	115	1	640–658	Zanzibar.
Lithosoma ochlerotatus sp. n.	105	1	280	,,
Astroceramus cadessus sp. n.	157	2	229	Maldives.
Milteliphaster wood-masoni Alcock	157	2	229	,,
Mabahissaster zengi gen. et sp. n.	106	1	183–194	Zanzibar.
Stellaster equestris (Retzius)	72	16	73	Arabian Sea.
Stellasteropsis colubrinus sp. n.	24, 27, 45, 53	30	13·5–200	Gulf of Aden, Arabian Sea.
S. tuberculiferus sp. n.	45	1	38	,, ,,
Monachaster umbonatus sp. n.	A	1	65–68	Gulf of Suez.
Anthenoides marleyi Mortensen	106	9	183–194	Zanzibar.
A. cristatus (Sladen)	194	495	220	Gulf of Aden.
Oreaster hiulcus Müller & Troschel	53	2	13·5	Arabian Sea.
Nardoa faouzii sp. n.	53	1	13·5	,, ,,
Narcissia mohamedi sp. n.	24, 157	2	73–229	Gulf of Aden, Maldives.
Ophidiaster purpureus Perrier	157	1	229	,,
Linckia multifora (Lamarck)	MB I	3	26–29	Red Sea.
Paranepanthia brachiata (Koehler)	24, 43, 45, 70	9	38–200	Gulf of Aden, Arabian Sea.
Henricia sp.	24	5	73–200	Gulf of Aden,
Henricia sp.	105	5	238–293	Zanzibar.
Dictyaster sp.	54	1	1046	Arabian Sea.
Acanthaster mauritiensis de Loriol.	53	1	13·5	,, ,,
Pteraster obesus H. L. Clark	157, 177	4	229–366	Maldives, Gulf of Aden.
Retaster sp.	27	1	37–91	,, ,,
Hymenaster alcocki Koehler	118	1	1789	Zanzibar.
Zoroaster alfredi Alcock	81	1	3351	Arabian Sea.
Z. angulatus Alcock	159	2	914–1463	Maldives.
Cnemidaster squameus (Alcock)	185	2	2001	Gulf of Aden.
Sclerasterias mazophorus (Alcock)	35, 194	19	220–549	,, ,,
Odinia austini Koehler	152	1	609–915	Maldives.
Brisinga trachydisca Fisher	108, 115, 124	10	640–914	Zanzibar.
B. gunnii Alcock	34	1	1022	Gulf of Aden.
Freyellaster spatulifer Fisher	118	2	1789	Zanzibar.

SYSTEMATIC ACCOUNT

Order PHANEROZONIA.

Family Porcellanasteridæ.

Sub-family Porcellanasterinæ.

Genus *Eremicaster* Fisher.

The following are the previous records for species of this genus; all are from the Pacific Ocean:

Species. (Synonyms in brackets.)	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
tenebrarius (Fisher)	Fisher, 1911	51	3	S. Alaska to Galapagos Is.	3867–4129 m.	Grey mud; grey ooze.
	Clark, 1913	1	1	W. coast of California	3217 m.	..
	,, 1920	24	5	Eastern tropical Pacific	3609–5121 m.	Various.
(*waltharii* Ludwig)	Ludwig, 1905	30	8	Gulf of Panama to Galapagos Is.	2418–4082 m.	Green mud; dark green sand; globigerina ooze.
pacificus (Ludwig) .	,, 1905	21	7	Ditto.	2070–3436 m.	Green mud; globigerina ooze.
	Fisher, 1911	6	3	Bering Sea, Alaska	1546–3187 m.	Grey ooze; green mud; brown ooze.
	Clark, 1913	11	3	W. coast of California	1586–1992 m.	..
	,, 1920	2	2	Eastern tropical Pacific	3609–4023 m.	Light grey and brown globigerina ooze; fine grey mud.
crassus (Sladen) .	Sladen, 1889	..	1	Mid-ocean, South Pacific	4267 m.	Red clay.
gracilis (Sladen) .	,, 1889	..	1	Off Chili	4067 m.	Blue mud.
vicinus Ludwig .	Clark, 1920	46	2	Off Peru	5121–5776 m.	Fine dark brown mud.

Eremicaster tenebrarius (Fisher).

Porcellanaster (*Eremicaster*) *tenebrarius*, Fisher, 1905, p. 293.
Porcellanaster waltharii, Ludwig, 1905, p. 92, pl. v, figs. 26 and 27.
Eremicaster tenebrarius, Fisher, 1911, p. 24, pl. i, figs. 1 to 4, pl. ii, fig. 4, pl. liii, figs. 4 and 4*a*.

Occurrence:

St. 171, SW slope of the Carlsberg Ridge, 3840–3872 m.; 24 specimens.

Remarks.—The specimens agree closely with the description of the American forms.

In all the larger examples each supero-marginal plate is armed with a spine equal in height to the plate itself (about 2·25 mm.), and two of the specimens have a second shorter spine on the third and fourth plates of each arm. The terminal plate bears five spines, a pair on the actinal edge of the outer wall directed outwards, a median spine above them, and proximally another pair which appear to continue the series of the supero-marginal spines. These two latter spines are barely 1 mm. long; the other three are equal in size to those of the supero-marginal plates. Segmental papillæ extend about a third of the way down the arm before becoming spiniform. No specimen has more than one true adambulacral spine. The specimens range in size from R 6 mm. to R 30 mm., and the table below shows some of the features which change as the animal grows :

R, mm.	r, mm.	R/r.	Number of SMPs.	Number of SMPs unarmed.	Number of spines on TP.	Number of rows of papillæ per cribriform organ.	
						Median organ.	Outer organ.
6	3	2·0	4	All	3	6	2
6	3	2·0	5	,,	3	8	0
7	3	2·3	3	,,	3	8	0
7	3	2·3	5	,,	3	8	0
7	3	2·3	5	,,	3	8	0
7	3	2·3	5	,,	3	8	0
7	3	2·3	5	,,	3	8	0
7	3	2·3	5	,,	3	8	0
8	4	2·0	4	None	3	6	2
9	4	2·2	5	,,	3	10	2
10	4	2·5	5	Interradials	3	8	2
10	4	2·5	5	All	3	8	4
10	5	2·0	5	,,	3	8	2
11	5	2·2	5	Interradials	3	8	2
15	7	2·1	7	None	3	14	6
15	6	2·5	5	,,	5	8	4
16	7	2·3	6	Interradials	3	14	6
16	7	2·3	6	None	3	16	8
20	8	2·5	7	,,	5	12	6
22	8	2·7	8	,,	5	10	6
23	10	2·3	9	,,	5	14	10
28	11	2·5	8	,,	5	12	6
33	12	2·8	12	,,	5	16	10
30	10	3·0	11	,,	5	14	10

(i) The R/r ratio, though variable owing to the distortion of the specimens, shows a definite increase with growth. (ii) The smallest forms have no supero-marginal spines. They tend to appear first on the plates of the ray, and then on every plate. (iii) The smaller specimens have three terminal spines only; the inner pair do not appear till later. (iv) The number of rows of papillæ forming a cribriform organ increases as the animal grows, and the two outer organs do not usually appear till the specimen has reached R 8 mm.

The young forms, which possess only a single cribriform organ, are indistinguishable from species of *Porcellanaster*, and are very different from the adult forms with three cribriform organs and supero-marginal spines. Nevertheless I believe that the trends shown in the table are sufficiently continuous to justify the inclusion of all the examples in one species.

Genus *Hyphalaster* Sladen.

Twelve species have up to the present time been ascribed to this genus, but Ludwig (1907) considers *H. valdiviæ* Chun to be synonymous with *Thoracaster cylindratus* Sladen, and *H. antonii* Perrier to be synonymous with *H. parfaiti* Perrier. Lieberkind (1932, 1935) adds *H. gracilis* Koehler and *H. fortis* Koehler to the list of synonyms of *H. parfaiti*, so that the number of species is thus reduced to eight. Their distribution is shown in the table below :

Ocean.	Species. (Synonyms in brackets.)	Number caught.	Number of stations.	Reference.	Locality.	Depth.	Bottom.
Pacific	*diadematus* Sladen	..	1	Sladen, 1889	W. of S. America	3800 m.	Blue mud.
	hyalinus Sladen	..	1	,, ,,	Mid-Pacific	5000 m.	Radiolarian ooze.
	inermis Sladen	..	1	,, ,,	S. of Japan	3000 m.	Blue mud.
	moseri Ludwig	2	1	Ludwig, 1905	,, ,,	4505 m.	Globigerina ooze.
Southern	*planus* Sladen	..	1	Sladen, 1889	..	3500 m.	Diatom ooze.
	scotiæ Koehler	..	..	Koehler, 1907	..	2538 m.	..
Indian	*tara* Alcock & Wood-Mason	..	..	Alcock and Wood-Mason, 1891	Bay of Bengal	3195–3650 m.	Globigerina ooze and pumice.
Atlantic	*parfaiti* Perrier	1	1	Perrier, 1894	Gulf of Gascony	4787 m.	Grey yellow mud.
		26	2	Lieberkind, 1932	Coast of Norway	2278–2400 m.	Blue mud.
		..	2	,, 1935	S. Greenland	3051–3087 m.	..
	(*antonii* Perrier)	1	1	Perrier, 1894	Azores	2995 m.	Soft white mud.
		2	2	Koehler, 1909*a*	Azores, Cape Verde Is.	3800–5430 m.	Sand and mud.
	(*gracilis* Koehler)	3	1	,, ,,	Coast of Spain	5413 m.	Globigerina ooze.
	(*fortis* Koehler)	3	2	,, ,,	Cape Verde Is., Azores	3890 m. 4360 m.	Sand and mud. Globigerina ooze.

Hyphalaster tara Alcock & Wood-Mason.

Hyphalaster tara, Alcock & Wood-Mason, 1891, p. 434, text-fig. 11.

Occurrence :

St. 171, SW slope of the Carlsberg Ridge, 3840–3872 m. ; 15 specimens.

Distribution.—Bay of Bengal ; Indian Ocean off NE Africa.

Description.—The following description is taken from one of the seven larger specimens, the dimensions of which are : R 20–25 mm . and r 8–12 mm. R/r varies

from 2·0–2·5. It is not possible to get a more accurate figure owing to the distortion which the specimens have suffered.

The *abactinal surface* is beset with rather small, well-spaced paxillæ, each bearing three or four rounded granules. At the base of each radius there is a conspicuous patch of larger paxillæ, each of which has ten to twenty granules. The proximal end of the patch is about 2 mm. from the centre of the disk ; the patch is some 3 mm. long by 1 mm. broad, and its distal end is about 6 mm. from the point where the third pair of supero-marginals come into contact. Each patch contains eighteen to twenty-four paxillæ in three irregular rows, and there are also two rows of large paxillæ lying parallel with, but separated by two rows of small paxillæ from, the four supero-marginal plates which bound the disk.

The madreporite, which measures about 1 mm. radially by 2 mm. tangentially, lies against the supero-marginals on one of the interradii and its sulci radiate from a point on its inside edge. The cribriform organs, three to each interradius, are composed of sixteen rows of papillæ. An epiproctal cone, 1 to 2 mm. long, is present.

There are six *supero-marginal plates*, of which the distal four are in contact with their opposites down the length of the ray. The first plate is about 3 mm. long, the next four 2·5 mm. long, and the sixth 2 mm. long. All are about 2 mm. high and are gently curved. For the most part they lie horizontally and form a broad border to the paxillar area, with the infero-marginal plates just visible beneath them, but this varies considerably with the condition of distortion of the specimen and the plates may lie almost vertically. They are always set at a steeper angle on the arms. The infero-marginals lie directly below the supero-marginals, but their height is uniformly less, decreasing from 2 mm. interradially to rather less than 1 mm. at the end of the arm. They stand vertically and do not encroach on the actinal surface.

The *terminal plate* is large, about 3 mm. long by 3 mm. high, faintly carinate and armed with four fine tapering spines, hyaline at the tip and 3 mm. long. The first spine is situated on the mid-abactinal line near the proximal edge of the plate and points vertically upwards. The second spine is also median and abactinal in position and projects upwards and outwards from a point near the distal edge of the plate. A pair of spines, directed horizontally, arise from the actinal border of the end wall of the terminal plate. The surface of the supero-marginal and terminal plates is covered by a series of very fine papillæ.

The *actinal intermediate areas* are paved with regular columns of rectangular, imbricating plates, devoid of spines. There are eight columns running at right angles from the infero-marginal plates to the adambulacral and mouth plates. There are also eight rows tangentially, but the arrangement in this direction is less regular. Each of the *adambulacral plates* bears a furrow comb of five or six short flattened and bluntly triangular spines ; these are usually folded back over the actinal surface of the plate, which is devoid of any armature. The *mouth plates* bear a pair of short stout conical spines projecting into the mouth cavity, and a comb of seven or eight spines, similar to those of the adambulacral plates, projecting into the furrow.

Variation.—Among the seven larger specimens the following variations are found : (i) One example shows a remarkable elaboration of the pattern formed by the large paxillæ. A second radial patch, of twelve to fifteen large paxillæ in two irregular rows, lies distal to the first and is separated from it by two or three rows of small paxillæ. About a

millimetre on either side of this second patch, and a little nearer the centre, there is a group of four to twelve large paxillæ. (ii) There is variation in the size of the large paxillæ, and this is particularly marked in the rows near the supero-marginal plates, for the component paxillæ of these are in some examples three to four times, in others barely twice, the size of their neighbours. (iii) One specimen has five small granules on the actinal surface of each mouth plate. In the rest the mouth plates have no actinal armature.

Young Forms.—Eight specimens have a major radius of between 6 and 12 mm. All that are not too badly damaged show a small patch of enlarged paxillæ on each radius. Other features are: R/r about 2·0; supero-marginal plates three to four; four to six furrow spines; three spines only on the terminal plate, the proximal of the two median spines being absent.

Hyphalaster giganteus sp. n. (Pl. I, figs. 3 and 7.)

Occurrence:

St. 171, SW slope of Carlsberg Ridge, 3840–3872 m.; 1 specimen.

Diagnosis.—Close to *Hyphalaster parfaiti* Perrier, differing mainly in lacking spinelets on the actinal intermediate plates. Disk large, inflated; arms long, thin and tapering; interbrachial arcs widely rounded; cribriform organs nine. Abactinal surface beset with uniform paxillæ, each with one or two central spinelets surrounded by a circle of seven to nine similar spinelets. Supero-marginals twenty-six, the distal twenty-one in contact abactinally. Infero-marginals corresponding to supero-marginals, except in middle of arm, where they are a little longer. Actinal intermediate plates rectangular, imbricating; arranged in radial and tangential columns; devoid of granules or spines. Adambulacral plates with four or five conical furrow spines and two fine acicular spinelets on the actinal surface. Mouth plates armed each with a strong spine projecting into mouth cavity, and six or seven furrow spines similar to those of adambulacral plates; actinal surface with five small hemispherical granules.

Description.—R 88 mm., r 24 mm., R/r 3·6. The single specimen is in poor condition, for it has only one complete arm, which was broken, but still attached, when the animal was brought up. The *abactinal surface* is much inflated, apparently by a large collection of mud in the stomach. It is covered by uniform close-set paxillæ, on each of which there is a whorl of seven to nine spinelets surrounding one, or occasionally two, similar spinelets, which are roughly twice as high as broad, slightly tapering and rounded at the tip. There is no epiproctal cone. The madreporite, lying against the supero-marginal plates on an interradius, measures 4·5 mm. tangentially and 4 mm. radially. Its furrows radiate from a point about 1·5 mm. from the inside edge.

The *supero-marginal plates* number twenty-six, and of these the distal twenty-one are in contact with the corresponding plate of the opposite side of the ray. The plates are longer than high in the interradius, square at the base of the arms, and thence higher than long, as is shown by the following measurements:

	Plate No. 1.	11.	20.	26.	
Length	5	3·5	2·5	1·25	mm.
Height	4	3·5	3	2	,,

Seen in section the plates slope inwards, are somewhat curved, and meet at a point so that the arm has the shape of a Gothic arch. The plates bordering the disk are similar in position and shape, but when seen from the side they are slightly tumid whereas along the arm the plates are quite flat.

In the middle of the single arm the *infero-marginals* are a little longer than the supero-marginals, but elsewhere they correspond with them except at the base of one of the broken arms, where injury is, perhaps, responsible for the irregularity. The plates are rectangular and do not encroach on the actinal surface. Their dimensions are :

	Plate No.			
	1.	10.	20.	26.
Length	5	4	3	1·75 mm.
Height	3	3·5	2	1 ,,

Both sets of plates are covered with very small papillæ, which to the naked eye give a " matt " effect. On the abactinal surface a strip of brownish pigment extends down the centre of each arm.

In two of the interradii there are nine *cribriform organs*, each extending over both supero- and infero-marginal plates. The outermost organ is made up of sixteen, the innermost of twenty rows of slightly elongate papillæ. The interradius in which the madreporite is lodged has but eight cribriform organs and these occur only between the infero-marginal plates ; between the supero-marginals only a few papillæ are to be seen, mostly lying near the upper edge of the plate ; the remainder have probably been scraped off. One of the arms has evidently been injured and regeneration has led to irregularity in the arrangement of the plates, for the infero-marginals no longer correspond to the supero-marginals. As a result two interradii have seven complete cribriform organs and one half-organ between the supero-marginals. In one case this lies isolated ; in the other two supero-marginal portions converge on one infero-marginal portion and form a Y-shaped organ.

The *actinal intermediate areas* extend to the eighth or ninth infero-marginal and the component plates lie in regular radial columns, of which the central column contains ten to twelve plates, and less regular tangential rows. As the outer border of the area is approached the plates show a decrease in size. Their surface is quite smooth.

The *adambulacral plates* are mostly badly damaged. There are four or five conical furrow spines, those in the centre nearly 2 mm. in length, those outside commonly about half this size. Near the outer border of the actinal surface two fine pointed spinelets, about 0·5 mm. long, are found.

Each *mouth plate* bears a robust spine directed into the mouth cavity and a furrow series of seven spines similar to those of the adambulacral plates. On the actinal surface five small hemispherical granules form two series, one parallel with the furrow and another parallel with the suture between the adjacent plates.

Affinities.—Two other species of *Hyphalaster* which possess nine cribriform organs have been described, and the table below shows the main differences between them and *H. giganteus* :

Species.	R.	R/r.	Number of SMPs.	Act. int. plates.
giganteus . .	88 mm. .	3·6 .	26 .	Bare.
parfaiti . . .	55 ,, .	3·0 .	16 .	Spiny.
moseri . . .	32·5 ,, .	2·5 .	11 .	,,

The greater R/r ratio and more numerous supero-marginal plates of *giganteus* are of doubtful significance in view of its greater size, but, on account of the complete absence of spines or granules on the actinal intermediate plates. it would not be justifiable to regard the present example as identical with either *H. parfaiti* or *H. moseri*. There is a possibility that it belongs to a known species, but is unrecognizable owing to the discrepancy in size between it and the described type, but there are no grounds for this view and the course open to least objection is the creation of a new species.

Sub-family Ctenodiscinæ.

Genus *Pectinidiscus* Ludwig.

Pectinidiscus annæ Ludwig.

Pectinidiscus annæ, Ludwig, 1907, p. 312; Lieberkind, 1932, p. 293, pl ii, figs. 3–8, pl. v, figs. 4–13, pl. vii, fig. 3.

Occurrence and Distribution.—The genus contains two species, *P. sibogæ* Döderlein, from the Malay Archipelago, and *P. annæ* Ludwig, of which all the known records are shown in the table below :

Expedition.	Station.	Number caught.	Locality.	Depth.	Bottom.
" Valdivia "	242	3	Off Dar-es-Salaam	404 m.	Green mud.
,,	243	2	,,	400 m.	..
,,	245	50	Zanzibar channel	463 m.	Globigerina ooze, blue clay.
" Mabahiss "	104	1	,,	207 m.	Grey green mud, sand and shells.
,,	106	38	,,	183–194 m.	Green mud.
,,	110	2	,,	347–348 m.	Grey green mud, sand and shells.

Remarks.—The table on p. 334 throws some light on some of the changes which accompany growth.

The changes which accompany growth are : (i) The R/r ratio increases. (ii) The number of supero-marginal plates bearing spines becomes proportionately greater. The variation in the absolute number of spines is noted by Lieberkind. (iii) It is characteristic

of adults to have smaller paxillæ on the epiproctal funnel and alongside the superomarginals. In small specimens in which R is less than 14 mm. only the paxillæ on the epiproctal funnel are noticeably smaller than those of the rest of the disk. (iv) The smaller specimens commonly have four instead of five furrow spines.

The paxillæ of the smallest specimens examined are surmounted by a crown of six to eight granules about a single one. This condition persists unchanged up to the largest, with the exception of the specimen with R 24 mm. from St. 106, in which some of the paxillæ bear as many as twelve peripheral granules.

St.	R, mm.	r, mm	R/r.	Number of SMPs.	Number of SMPs armed.
106	6	2·75	2·1	6	3
104	6	2·5	2·4	7	0
106	7	3	2·3	7	0
,,	7	3	2·3	7	0
,,	7	3	2·3	7	2
,,	7	3	2·3	7	2
,,	7	3	2·3	7	3
,,	7·5	3·5	2·1	7	3
,,	7·5	3·5	2·1	7	3
,,	8	4	2	7	2
,,	8	3·5	2·3	7	3
,,	8·5	4	2·1	7	4
,,	8·5	3·5	2·4	7	4
,,	9	3·5	2·5	7	2
,,	9	3·5	2·5	7	3
,,	9	3·5	2·5	7	4
,,	9	3·5	2·5	7	4
,,	9	3·5	2·5	7	4
,,	9	3·5	2·5	7	3
,,	9·5	3·5	2·7	7	4
,,	9·5	4	2·4	7	5
,,	10	4	2·5	7	2
,,	10	4	2·5	8	5
,,	11	4·5	2·4	7	5
,,	11	4·5	2·4	8	3
,,	11	4	2·75	7	5
,,	11·5	4·5	2·8	11	3
,,	13·5	5	2·7	9	6
,,	13·5	5·5	2·4	10	6
,,	14	5·5	2·5	9	6
,,	14	5	2·8	11	6
,,	14	5·5	2·5	10	8
110	17	6	3	11	9
106	24	8	3	14	10
110	33	11	3	16	13

Family Astropectinidæ.

Genus *Astropecten* Gray.

Döderlein (1917) has monographed this genus.

Astropecten polyacanthus Müller & Troschel.

Astropecten polyacanthus, Müller & Troschel, 1842, p. 69; Döderlein, 1917, p. 134, pl. iv, figs. 4, 5, pl. xii, figs. 4, 5.

Occurrence :

St. 27, Gulf of Aden, 37–91 m., sand and shingle ; 1 specimen.

St. 146, Maldives, 37 m., soft cream mud ; 105 specimens.

Distribution.—Widely distributed throughout the tropical Indo-Pacific region.

Astropecten griegi Koehler.

Astropecten griegi, Koehler, 1909, p. 26, pl. vii, fig. 4, pl. x, fig. 6 ; Döderlein, 1917, p. 117, pl. i, fig. 6, pl. x, figs. 1, 1*a*.

Occurrence :

St. 143, Maldives, 797 m., green sand ; 5 specimens.

St. 145, Kardiva Channel. Maldives, 494 m., green mud and sand ; 8 specimens.

Distribution.—Laccadive Sea and Andaman Sea, 236–850 m. ; Maldives.

Remarks.—The dimensions of twelve of the thirteen specimens are as follows :

	Specimen.												
	Station 143.				Station 145.								
	1.	2.	3.	4.	1.	2.	3.	4.	5.	6.	7.	8.	
R .	60	48	..	..	50	48	45	42	40	25	..	..	mm.
r .	9	8	7	7	8	8	7	8	8	5	8	5	,,
R/r .	6·6	6·0	..	..	6·2	6·0	6·3	5·2	5·0	5·0	..	..	

Astropecten pusillulus Fisher.

Astropecten pusillulus, Fisher, 1906, p. 1008, pl. i, fig. 3, pl. ii, figs. 4, 4*a*, 4*b*.

Occurrence :

St. 153, Maldives, 256–293 m. ; 1 whole specimen and 1 disk.

Distribution.—Hawaiian Islands ; Maldives. Fisher records 650 specimens from 267–683 m. at the former locality.

Remarks.—R 55 mm., r 11 mm., R/r 5·0 ; breadth of ray at base 9 mm., number of SMPs, 35. The single entire specimen is in good condition, and though larger, agrees

closely with the description of the Hawaiian forms. While the majority of the paxillæ resemble those of the type in having one central and six to eight peripheral granules, a few of the largest at the base of the ray have as many as twelve peripheral and three central. The infero-marginals are armed with two spines, the outer 3 mm. and the inner 2·75 mm. long. A third much smaller spine is present on the proximal plates. There are three small spines on the first plate. Pedicellariæ occur on the actinal intermediate and on many adambulacral plates.

Colour.—Paxillar area, light greyish olive; supero-marginals white, with a continuous longitudinal line along the outer edge and a series of transverse stripes across the abactinal surface scarlet; infero-marginals and actinal surface white; tube feet avellanous.

Astropecten monacanthus Sladen.

Astropecten monacanthus, Sladen, 1889, p. 216, pl. xxxvii, figs. 10–12, pl. xxxiii, figs. 7, 8; Döderlein, 1917, p. 150, pl. xiv, figs. 5, 5*b*, pl. xvii, fig. 9.

Occurrence:

St. 80, off Ras al Hadd at the eastern point of Arabia, 16–22 m., coarse sand and shells; 3 specimens.

Distribution.—Widely distributed in the tropical Indo-Pacific region.

Remarks.—The dimensions of the three specimens are:

	Specimen.			
	1.	2.	3.	
R	53	44	41	mm.
r	14	13·5	12	.,
R/r	3·8	3·2	3·4	

Genus *Persephonaster* Alcock & Wood-Mason.

A synopsis of the known species of this genus is given by Döderlein (1921, p. 26).

Persephonaster cingulatus (Fisher).

Psilasteropsis cingulata, Fisher, 1906, p. 1023, pl. iii, figs. 2, 2*a–b*, pl. vii, figs. 1, 2, 3, pl. viii, fig. 2.
Persephonaster cingulatus, Fisher, 1919, p. 111.

Occurrence:

St. 185, Gulf of Aden, 2000 m., green mud; 1 specimen.

St. 118, Zanzibar, 1789 m., globigerina ooze; 1 specimen.

Distribution.—Previously known only from the Hawaiian Islands.

Remarks.—The dimensions of these two specimens are as follows:

Gulf of Aden specimen: R 125 mm., r 24 mm., R/r 5·2.

Zanzibar specimen: R 92 mm., r 19 mm., R/r 4·9.

The following are measurements of the larger specimen :

	Plate No.					
	2.	6.	10.	15.	20.	25.
Breadth of arm . .	24 .	21 .	17 .	13 .	10 .	6·5 mm.
,, of paxillar area .	19 .	11 .	8 .	6 .	4 .	3 ,,
Number of paxillæ .	23 .	17 .	13 .	9 .	7 .	*c*.7

The outer border of each supero-marginal is somewhat pointed and the distance between the points is taken as the breadth of the arm. The number of paxillæ is the number in the chevron running across the ray from one marginal plate to the other.

Abactinal surface.—Except in the very centre and alongside the marginal plates, where they are a little smaller, the paxillæ of the disk are uniform in size and on their circular tops stand about thirty short round-tipped spinelets. A similar number surmount the paxillæ at the base of the ray ; in this region the tops of the paxillæ are twice as long as broad, but as they decrease in size along the ray their length may reach three times their breadth, for near the tip of the ray there are some with two parallel rows of six granules. The paxillæ of the arms lie in chevrons, each arching in a gentle curve across the arms from supero-marginal to supero-marginal, the convexity being directed towards the centre.

There are thirty-eight *supero-marginals*. The first four plates are narrow but the abactinal face of the next few encroaches more and more on to the paxillar area. The height of the first plate is a little over twice its length, but on successive plates the height decreases and the length increases slightly, and from the tenth plate to the tip of the ray the two dimensions are equal. Each plate is strongly and acutely tumid, the median ridge lying in the centre of the first few plates but coming to lie nearer the distal margin of the remainder. The plates are covered with fine short capillary spinelets, but as these mount the ridge they become larger and much flatter, till they are little more than bosses. The actual summit of the ridge is occupied by a row of about ten of these flat bosses, larger than all the rest and equal in diameter to the base of one of the infero-marginal spines.

The *infero-marginals* correspond with the supero-marginals but their height is a little less, and they encroach more on to the actinal surface than do the supero-marginals on to the abactinal. The actinal surface is slightly convex, while the lateral face is raised into a ridge running obliquely from a point below the ridge of the supero-marginal above to the distal edge of the plate. The ridge bears four fine tapering appressed pointed spines. The uppermost is usually only about a quarter the length of the remainder, which are 4 to 5 mm. long. Either all three are of the same length, or the lowest is a little shorter than the other two. An extra spine stands on the lower proximal border of the first two plates. The rest of the plate is covered with pointed squamules which become smaller towards the edge.

The *actinal intermediate areas* are small, and comprise four chevrons of plates. Of the twenty plates in the innermost chevron, six extend in a contiguous series to the fourth infero-marginal, while the rest lie isolated and attain the twelfth infero-marginal. The next chevron contains six plates reaching the third infero-marginal ; the third contains four plates reaching the second infero-marginal ; while the outermost contains three

plates, which reach only the distal border of the first infero-marginal. The plates are covered with papilliform spinelets, of which one in the centre often stands out from the rest and reaches a length of 2 mm.

The *adambulacral plates* have a strongly angular margin, the proximal facet being the shorter, especially on the first three plates. There are nine to eleven closely crowded, slightly flattened, round-tipped subequal furrow spines, 2 mm. or a little more in length, Actinally stand twelve to fifteen spines irregularly arranged, similar to the furrow spines but smaller, those in the centre of the plate about half, those near the outer border about a quarter as long.

The *mouth plates* bear a furrow series of nine or ten closely crowded spines, which are smaller than those of the adambulacral plates. The inner angle of each plate is occupied by an enlarged spine, about 3 mm. long by 1 mm. broad. The spines of adjacent plates lie together and bear a striking resemblance to a cloven hoof. The strongly salient actinal surface of the plates is occupied by short spines lying in two groups. The first group consists of seven spines in two ill-marked rows parallel with the suture between the mouth plate and the first adambulacral plate. The second group consists of twelve spines in two irregular rows parallel with the suture between adjacent mouth plates. The row next the suture is made up of eight closely crowded spines, the other of four well-spaced spines.

The smaller specimen agrees with the above description except that the first four or five infero-marginal plates bear five or six spines.

Comparison with Fisher's description of *Persephonaster cingulatus* reveals some small differences ; the Hawaiian form has slightly broader supero-marginals ; eleven to thirteen, instead of nine to eleven furrow spines ; and more numerous actinal mouth spines. These differences, however, do not seem great enough to merit specific recognition.

The *colour* was not matched, but the larger specimen is recorded as being "an intense dark red with lighter marginal plates ". In spirit it is brownish.

Persephonaster sewelli sp. n. (Pl. I, figs. 5 and 6 ; Text-fig. 1.)

Occurrence.—At the following stations all near Zanzibar :

St. 105, 238–293 m., green mud ; 5 specimens.

St. 110, 347–384 m., grey-green mud and sand ; 2 specimens.

St. 115, 640–658 m. ; 1 specimen.

St. 123, 256–366 m., green mud, sand and rocks ; 1 specimen.

Diagnosis.—R/r 5. Actinal surface flat, abactinal surface slightly raised. Arms long, tapering evenly to an attenuate point. Abactinal paxillæ rather small, well spaced, bearing a brush-like arrangement of some twenty-five bluntly-pointed spinelets about 0·5 mm. in length. Supero-marginals forty, forming well-marked border to paxillar area ; slightly tumid ; armed with a short robust spine, accompanied in distal half of ray by a second shorter spine ; covered with squamules centrally and several rows of capillary spinelets near distal and proximal edges. Infero-marginals with three or four fine tapering appressed spines ; first two plates with actinal spines in addition ; plates covered with squamules coarser than those of supero-marginals and two rows of capillary spinelets near adjacent edges. Actinal intermediate areas small, comprising four irregular chevrons ; plates bearing twelve to twenty spinelets ; pedicellariæ, composed of about

half the total number of spines, present on first few plates of innermost chevron, a tapering spine springing from centre of first few plates of remaining chevrons. Adambulacral plates with six furrow spines and on the actinal surface two rows of four or five more delicate spines. Mouth plates with five furrow spines, the proximal edge straight, the distal edge convex; actinally three rows of spinelets, the three innermost of the row alongside the suture between adjacent plates greatly enlarged.

Description.—The measurements of eight of the specimens are as follows:

R.	r.	R/r.	From Station—
80 mm.	16 mm.	5	105
76 ,,	15 ,,	5	105
76 ,,	15 ,,	5	110
75 ,,	15 ,,	5	105
75 ,,	15 ,,	5	110
65 ,,	13 ,,	5	105
33 ,,	8 ,,	4	105
29 ,,	7 ,,	4	123

The *abactinal surface* is beset with rather small well-spaced paxillæ, which are largest in the interradius and at the base of the ray, and become smaller in the centre, in the neighbourhood of the supero-marginals, and down the length of the arms. They stretch across the arms in lines that are almost straight but show a slight arching towards the centre of the disk. The number of paxillæ per row between successive pairs of supero-marginals is shown in the table below. The larger paxillæ are surmounted by a brush-like arrangement of about twenty-five roundly pointed spinelets, approximately 0·5 mm. in length.

	SM plate No. 1.	4.	8.	12.	16.	20.	24.	30.
Breadth of arm	21	16	12	10	8	6	4·5	3 mm.
,, of paxillar area	18	12	7·5	5·5	4·5	3·25	2	1·5 mm.
Number of paxillæ	..	23	15	15	11	9	5	3

The *supero-marginals* form a well-marked border to the paxillar area throughout, though they encroach more on the arms than on the disk. The first two plates are high, narrow and short, but the height of successive plates decreases while the breadth and length, which are always equal, increase up to the tenth plate.

Dimensions:

	Plate No. 1.	5.	10.	15.	
Height	2·5	1·75	1	0·75	mm.
Length	1·5	2	2·25	2	,,
Breadth	1·5	2	2·25	2	,,

The plates are slightly tumid; the apex of the tumidity occupies the centre of the first two plates, but on succeeding plates approaches the distal border. On the apex, near the outer edge of each plate, there is a robust pointed spine, 1 to 1·5 mm. in length. On the outer half of the ray a smaller one may stand close beside it. The plates are covered with small, rather elongate pointed squamiform granules, of which a few round

the base of the spine are enlarged. Towards the suture between adjacent plates the squamules are replaced by several rows of fine capillary spinelets.

The *infero-marginals* form a well-defined border to the actinal surface, but, unlike the supero-marginals, they are broader than long, and they are low in the interradius and increase in height at the base of the rays. Dimensions :

	Plate No. 1.	5.	10.	15.
Height	1·5	2	1·5	1 mm.
Length	1·75	2	2	1·5 mm.
Breadth	3	3	3	2 ,,

The first two plates bear three spines, 2 to 3 mm. long, on the middle of the lateral surface and, unlike all the rest of the plates, one or two shorter spines on the actinal surface. The plates of the proximal half of the ray bear near the distal border of the lateral surface four, or sometimes only three, fine tapering appressed spines, of which the two in the centre are longer and more robust. The lower of these two central spines is a trifle the longer and attains a length of 5 or 6 mm. On the plates of the distal half of the ray there are only three spines. The surface of the plates is covered with squamiform granules, which are coarser and less pointed than those of the supero-marginals. About the bases of the spines these squamules are elongated, and at the edges, near the sutures between adjacent plates, they give place to about two rows of capillary spinelets.

The *actinal intermediate areas* are small, and the plates are arranged in four rather irregular chevrons. The first chevron contains twenty-two plates, extending beyond the third infero-marginal as a series of isolated plates which reach the fifteenth infero-marginal. The next two chevrons contain respectively nine and six plates reaching the fourth and third infero-marginal. A fourth chevron consists of three plates lying parallel with the interradial suture. The plates project as irregular, round or oval bosses, on which stand a number of delicate round-tipped or pointed spinelets, measuring perhaps 1 mm. in length. On the first five plates of the innermost chevron the spines number sixteen to twenty and as many as half of them may be grouped together into a pedicellaria. On the first two or three plates of the remaining chevrons the spines number twelve to sixteen, and from their midst emerges a more robust tapering pointed spinelet 2 mm. or more in length.

The furrow margin of the first three or four *adambulacral plates* is strongly angular, the proximal facet being the shorter. The rest of the plates have an evenly rounded furrow margin. This bears six parallel slightly flattened spines, which taper at the tip to a rounded point. The two outer spines are always shorter than the rest; the two inner spines, which reach a length of 3·25 mm., are sometimes a little longer than the spine on either side of them, sometimes of the same length. Two rows of four or five spines stand on the actinal surface of the plate. They resemble the furrow spines but are shorter and more delicate. Those of the inner row are about half as long as the furrow spines, those of the outer a little shorter than those of the inner row. One or two spines are often found between the two rows or outside the outer one.

Mouth plates (Text-fig. 1).—Over the very salient actinal surface of each plate and alongside the suture which separates it from its neighbour runs a row of fifteen spines. Distally these are small and round-tipped, centrally they are squamiform, while beyond

the middle they begin to elongate again, and the proximal three are successively larger as they near the mouth angle, where the innermost projects as a vast, bluntly pointed tooth. Parallel with this row a line of seven smaller round-tipped or pointed spines runs down the centre of the plate. The border adjacent to the first adambulacral plate is occupied by nine spines, most a little larger than those of the middle row, and the series is continued by four spines which lie on the free border of the mouthplate, immediately above the furrow spines. These latter, five in number, are lodged deep within the furrow. They are flattened, somewhat pointed, straight-sided proximally and convex distally.

Text-fig. 1.—*Persephonaster sewelli* sp. n. Mouth plate × 12½.

Young Forms.—The two young specimens, with R 29 and 33 mm., have all the characters of the larger forms, including actinal infero-marginal and actinal intermediate spines. The differentiation between the two types of granule on the marginal plates is less well marked but is still clearly to be distinguished.

Affinities.—I have, through the kindness of the Indian Museum, been able to compare the present specimens with Alcock's type of *Persephonaster cœlochiles*. The arms of this species are broad at the base and remain parallel-sided for a short distance before beginning to taper. The arms of *P. sewelli* taper from the base, and their tip is more attenuate than in *P. cœlochiles*. Further this latter species has more tumid supero-marginals, and their entire surface is covered by capillary spinelets; the infero-marginals also lack any trace of squamules and their spines usually number only three; and the actinal plates lack central spinelets.

I think this species would fall into section *a*3 of Fisher's key (1919, p. 111), but the chief criterion is whether the supero-marginals are, or are not, massive, and this character is difficult to assess in the absence of specimens with which comparison can be made. Its nearest relatives would seem to be *P. habrogenys* Fisher and *P. œdiplax* Fisher. The latter species has shorter rays, no squamules on the marginal plates, no actinal spines

and pedicellariæ on the abactinal, marginal, actinal intermediate and adambulacral plates. *P. habrogenys* has longer arms, small infero-marginals with actinal spines, no spines on the actinal intermediate plates and abactinal pedicellariæ.

The species is named *sewelli* after Lt.-Col. R. B. Seymour-Sewell, leader of the expedition.

Persephonaster gracilis (Sladen).

Psilaster gracilis, Sladen, 1889, p. 230, pl. xli, figs. 5 and 6, pl. xlii, figs. 9–11.
Dytaster anacanthus, Alcock & Wood-Mason, 1891, p. 424; Alcock, 1893, p. 80.
Persephonaster gracilis, Fisher, 1919, p. 123.
Persephonaster anacanthus, Fisher, 1919, p. 133.

Occurrence:

St. 81, Gulf of Oman, 3351 m., grey clay; 1 specimen.

St. 120, Zanzibar area, 2926 m., brown mud; 1 specimen.

St. 171, Carlsberg Ridge, 3840–3872 m.; 1 specimen.

Distribution.—Japan, 3373 m., blue mud (Sladen), Bay of Bengal, 3195 m., globigerina ooze and pumice (Alcock); Gulf of Oman, Carlsberg Ridge, Zanzibar.

Description.—The measurements of the specimens are: St. 81, R 92 mm., r 16 mm., R/r 5·7; St. 120, R 55 mm., r 10 mm., R/r 5·5; St. 171, R 85 mm., r 15 mm., R/r 5·6. The following description is taken from the two larger specimens. The disk is flat. The arms taper abruptly at the base and then more gradually to a blunt tip. In transverse section they are rectangular at the base, round distally. The interbrachial arcs are acutely rounded.

The largest paxillæ on the *abactinal surface* have a diameter of about 0·5 mm., and occur on the interradii and the base of the arms. On the arms the paxillæ are twice as long as broad, and lie between the supero-marginals in chevrons which show only a very slight arching towards the centre of the disk. Two or three chevrons correspond to one supero-marginal plate. Each paxilla is uniformly beset with cylindrical round-tipped or slightly clavate granules, which stand up vertically. The madreporite has a diameter of 2 mm., and lies a little nearer to the edge of the disk than to the centre.

There are forty-two *supero-marginals*, which encroach on to the abactinal surface only in the distal half of the rays. The first plate is high and short. The second and third plates show an abrupt, the remainder a gradual, decrease in height, while the length increases a little up to the tenth plate.

Dimensions:

	Plate No. 1.	5.	10.	20.	30.	
Height	4·5	3·25	3	2	1·5	mm.
Length	1·75	2	2·5	2	1·5	„

The first ten plates are flat, the rest are rounded. Their surface is covered with a close-set nap of fine, slightly elongated granules, similar to those on the abactinal paxillae but more pointed.

The *infero-marginal plates* correspond to the supero-marginals and resemble them in size and shape, except that all encroach on to the actinal surface. The first plate bears three fine pointed spines, about 4·5 mm. long, on the centre of the lateral face. A

similar row is found on the remaining plates but it is set obliquely, the lowest spine almost on the distal border, the uppermost near the centre of the abactinal border of the plate. The granules of the infero-marginals are more robust and pointed than those of the supero-marginals, and on the actinal surface of each plate they are longer and attain a length of about 0·75 mm.

The *actinal intermediate areas* are very small. The plates lie in three fairly well-defined chevrons, without any median plates lying on the interradial line. The innermost chevron has eight plates, of which the proximal four are in contact, and the distal four lie isolated and extend to the level of the seventh infero-marginal. In the second chevron there are five plates reaching the third infero-marginal, while the outermost contains four plates which extend no further than the distal edge of the first infero-marginal. The plates are beset with robust pointed spinelets closely crowded together.

The first two or three *adambulacral plates* have a strongly angular margin, of which the proximal facet is the shorter; the rest have a uniformly rounded margin. The furrow spines number seven, of which, on the angular plates, two stand on the proximal and five on the distal facet. The spines are subequal, about 2 mm. long, stout, bluntly pointed at the tip and invested with membrane which often gives them a clubbed appearance. The actinal surface of the plate bears eight to ten irregularly arranged spines similar to the furrow spines but of half to two-thirds the size.

On the inner angle of each *mouth plate* stands a vast spine which in one specimen is shaped like a mortar trowel but which in the other is narrower and like the one figured by Sladen. Close behind are two spines side by side, similar, but barely half the size. Parallel with the suture between adjacent plates a row of nine or ten spines like those of the actinal intermediate plates runs from the proximal to the distal corner. A row of similar but slightly smaller spines lies parallel with this, and a third row runs round the free margin of the plate. Below it, deep within the furrow, lie five or six furrow spines rather shorter than those of the adambulacral plates.

Colour.—The colour of the specimen obtained at St. 171 was a uniform aster purple with the marginal spines a little darker.

Affinities.—The specimens have been compared with an example of *Dytaster anacanthus*, kindly lent by the Indian Museum, and with the type of *Psilaster gracilis* at the British Museum, and I have little doubt that they are one and the same species.

Genus *Dipsacaster* Alcock.

A list of the known species of *Dipsacaster* is given by Döderlein (1921, p. 18). There are two additions to be made to this list: *Lonchotaster magnificus* H. L. Clark (1916, p. 30, pl. vi, figs. 1 and 2: Great Australian Bight, 144–216 m.), which is referred to the genus *Dipsacaster* by Fisher (1919, p. 150), and *Dipsacaster grandissimus* Goto (1914, p. 252, pl. viii, figs. 136–139; pl. ix, figs. 140 and 141: Japan, 640 m.).

Dipsacaster farquharsoni sp. n. (Pl. I, figs. 1 and 4.)

Occurrence:

St. 157, Maldives, 229 m., coral rock; 1 specimen.

Diagnosis.—R/r 2·7. Body rather flat. Arms broad at base, tapering somewhat rapidly to a blunt point. Interbrachial arcs widely rounded. Paxillar area small; paxillæ

tabulate and arranged in chevrons; the largest with a central group of ten to fifteen pointed granules, and a radiating peripheral series of thirty to thirty-five fine slightly clavate spinelets. Supero-marginals very broad; confined to abactinal surface; beset with large flat angular granules and fine clavate spinelets at edge. Infero-marginals very broad; defining ambitus; beset with squamules, which elongate near outer edge of plate, two or three projecting as flattened blade-like spines; other edges with clavate spinelets. Actinal intermediate areas large, reaching thirteenth infero-marginal; plates with raised oval tabula on which stand thirty to forty coarse radiating clavate spinelets, of which one is often enlarged. Adambulacral plates with nine or ten spines on inner (furrow) margin, and three or four on outer and lateral margins; furrow spines fine long radiating, spines on outer margin about half size of furrow spines, spines on lateral margins decreasing in size as furrow approached; three spines in centre of actinal face.

Description.—R 60 mm., r 22 mm. The *paxillar area* is not extensive, and its breadth at the levels of successive supero-marginals, together with the total breadth of the ray at the same levels, is shown in the table below:

	Plate No. 2.	5.	10.	15.	20.	25.	
Breadth of ray	25	19	14	10	8	6·5	mm.
,, of paxillar area	15	8·5	5	3·5	2·25	2	,,

The largest paxillæ have a diameter of about 1 mm. and occur on the disk, four of the largest actually on the madreporite. The paxillæ become smaller towards the centre and edges of the disk and along the arms. They are well spaced and arranged in angular chevrons directed towards the centre of the disk. Two chevrons correspond to one supero-marginal, and the number of paxillæ in the chevrons between successive pairs of supero-marginal plates is shown below:

	Plate No. 1.	3.	6.	12.
Number of paxillæ	19	13	11	7

The top of one of the larger paxillæ has ten to fifteen short cylindrical bluntly pointed granules in the centre and a ring of thirty to thirty-five longer finer spinelets, which show a tendency to become clavate, radiating from the edge. The base of each paxilla is six-rayed. Papulæ emerge between these rays all over the disk and down the arm nearly to its tip.

There are thirty *supero-marginal plates* forming a broad, gently sloping border to the paxillar area; the infero-marginals, which in the interradius project 2 mm. beyond the supero-marginals, alone define the ambitus. The first supero-marginal is about three-and-a-half times as broad as long. The breadth diminishes on subsequent plates, while the length increases and reaches a maximum at the tenth plate, but it remains less than the breadth to the tip of the ray. Dimensions of supero-marginal plates:

	Plate No. 1.	5.	10.	15.	20.	25.	
Length	1·5	2	2	1·75	1·25	1	mm.
Breadth	5·5	5	3·5	3	2·5	2	,,

The surface of the plate is covered with large flat angular granules in five or six irregular rows, while a series of fine clavate spinelets runs along the edges adjacent to the paxillæ and the neighbouring supero-marginal plates. The *infero-marginal* plates correspond exactly with the supero-marginals, and like them are very broad, particularly in the interradius. Each bears about three rows of squamiform granules that are considerably coarser than those of the supero-marginal plates. Towards the outer edge of the plate the squamules become elongated and two, three or even four attain a length of 2 mm. and project as pointed blade-like spines. The spinelets along the other edges of the plate resemble those similarly placed on the supero-marginal plates but are larger and more clavate.

The *actinal intermediate plates* are arranged in four chevrons containing successively twenty-four plates reaching the thirteenth infero-marginal, twelve reaching the sixth, seven reaching the fourth, and four reaching the third infero-marginal. This last chevron encloses three plates, one lying on the interradial line, one on either side of it. Each plate bears on a raised rounded lozenge-shaped tabulum thirty to forty coarse radiating strongly clavate spinelets of which one is often enlarged.

The *adambulacral plates* bear nine or ten long flattened round-tipped furrow spines on a uniformly convex margin. In the centre of the actinal face of the plate three spines stand in an oblique row. These spines are as thick as the furrow spines but only half as long and the axis of flattening is parallel with, instead of at right angles to the furrow. Along the other edges of the plate is a series of about ten spines. Three on the actinal edge resemble the central spines, but those on the edges adjacent to the neighbouring adambulacral plates become finer and shorter as the furrow is approached.

The *mouth plates* bear thirteen furrow spines similar to those of the adambulacral plates and a large number of actinal spines. A row of six round-tipped slightly tapering spines, lying parallel with the furrow, are about half as long as the furrow spines. A second parallel row contains six spines which are a little shorter and in some cases a little thicker. Two irregular rows each containing about six short thick clavate spines lie parallel with the suture between the two adjacent plates. The border adjoining the first adambulacral plate is beset with a number of short fine spines.

Affinities.—I have been able to compare this specimen with examples of two species previously recorded from the Indian Ocean. The British Museum contains a specimen of *D. sladeni* from the Cape of Good Hope. It differs from *D. farquharsoni* in many respects, notably: (i) The paxillæ are smaller and more numerous; (ii) the supero-marginals are almost square throughout; (iii) the infero-marginals are covered with spiniform, not squamiform spinelets, and the enlarged spinelets are much smaller; (iv) the spinelets of the actinal intermediate areas are not clavate. Alcock's type of *D. pentagonalis* was kindly lent by the Indian Museum. It also has but a slight affinity with the present species and differs in the following features: (i) The rays taper less; (ii) the paxillar spinelets are longer and fewer and the peripheral spinelets are not clavate; (iii) the supero-marginals are broader than long but the ratio of these two dimensions is less than in *farquharsoni*; (iv) the infero-marginal spines are round, not flattened; (v) the adambulacral plates have only five furrow spines and one of the actinal spines is enlarged.

The extremely broad supero-marginals of *D. farquharsoni* serve to distinguish it from all other species of *Dipsacaster* except *D. grandissimus* Goto (1914) and *D. pretiosus* Döderlein (1902). The latter is probably the most closely related form, but may be

distinguished by the fewer furrow spines (five), the more abundant granulation on the abactinal and marginal plates, and the enlarged infero-marginal spinelets not projecting beyond the edge of the plate. The infero-marginals of *D. grandissimus* are " uniformly covered with a thick coat of very fine, somewhat flattened spines of a silky appearance ".

The species is named after Lt.-Cmdr. W. I. Farquharson, R.N., navigator and surveyor to the expedition.

Immature Astropectinidæ.

Young forms were taken at the following stations :

St. A, Gulf of Suez, 65–68 m. ;	*Astropecten* sp.	1 specimen.
St. 10, Red Sea, 55 m. ;	,,	1 ,,
St. 34, Gulf of Aden, 1022 m. ;	,,	1 ,,
St. 43, S. Arabian coast, 83–100 m. ;	,,	2 specimens.
St. 66, Gulf of Oman, 609 m. ;	,,	2 ,,
St. 70 ,, ,, 196 m. ;	,,	55 ,,
St. 71, ,, ,, 106 m. ;	,,	1 specimen.
St. 143, Maldive area, 797 m. ;	*Persephonaster* sp.	1 ,,
St. 145, ,, ,, 494 m. ;	Astropectinids,	2 specimens.
St. 171, Central part, Arabian Sea, 3840–3872 m. ;	Astropectinid,	1 specimen.

The specimen from St. A is larger than the rest and, though too small for definite identification, shows features of some interest : R 24 mm., r 8 mm., R/r 3 ; breadth of ray at level of fifth supero-marginal 7 mm., breadth of paxillar area at same level 4 mm. The arms taper to a bluntly pointed tip.

The *paxillæ* are small and closely crowded on the centre of the disk, large and less crowded at the base of the ray, small and well-spaced half-way down the ray where three rows correspond to one supero-marginal plate. Each bears a peripheral series of eight to thirteen short radiating clavate spinelets and usually there is a single central granule, but on the larger plates at the base of the ray there may be as many as five.

There are twenty *supero-marginal plates*, each one a little broader than long and beset with about five irregular rows of well-spaced hemispherical granules which are rather larger than those of the paxillæ. Along the edge of each plate the granules become finer and elongate.

A broad flattened pointed spine, some 2 mm. long, occupies the centre of the upper border of each *infero-marginal plate*. Immediately below it is an oblique row of three or four fine spines, of which the distal is the largest ; it is a little more than half the length of the main spine. On the actinal surface of the plate four or five rather smaller pointed spinelets lie in a row just distal to the median line. On the first two or three plates a second similar row lies on the proximal side of the median line. The rest of the surface of the plate is beset with small well-spaced sharply pointed granules.

On each side of the interradial line there are three *actinal intermediate plates* each bearing a tuft of slightly clavate granules. In one interradius which has been closely scraped there lies what appears to be a rudimentary fourth plate.

The adambulacral plates bear three tapering pointed *furrow spines*, the central a little longer and finer than the others. In the middle of the actinal surface of the plate there are two spines, the distal similar to one of the outer furrow spines, the proximal usually distinctly smaller. Between these two spines and situated nearer the outer border of the plate is a much finer spine.

If this specimen really has four actinal intermediate plates it is very close to, perhaps identical with, the Australian species *A. problematicus* Döderlein (1917, p. 163). The characters of the rest of the body would place it in Döderlein's *scoparius* group, the most nearly related species being *scoparius* itself. This group, however, is biventral, though Döderlein records in one of its members (*kagoshimensis*) the occurrence of three actinal intermediate plates as an abnormality.

Family Luidiidæ.

Döderlein (1920) has monographed this family.

Genus *Luidia* Forbes.

Luidia prionota Fisher.

Luidia prionota, Fisher, 1913*a*, p. 202 ; 1919, p. 164, pl. xli, figs. 5, 5*a*, pl. xlv, figs. 1, 2.

Occurrence :

St. A, Gulf of Suez, 65–68 m., soft yellow mud ; 2 specimens.

Distribution.—Philippines, 20 m. ; Gulf of Suez.

Remarks.—No arms are whole but the minor radii of the two specimens are 7·5 and 9 mm. One specimen has two actinal intermediate pedicellariæ, but, except for these, pedicellariæ are confined to the mouth plates. The adambulacral armature has the same arrangement as in the type, but the relative sizes are rather different. The upcurved furrow spine is about equal to the length of the plate, instead of one-and-a-half times as long as in the type, while the spine just outside it is nearly twice the length of the plate. Of the pair which stands just external to this, the distal spine, is only a little smaller, but the proximal is much shorter and finer, barely half the length of its companion. The spines of succeeding rows are similar to this little one. With this one exception the specimens agree with Fisher's description of the Philippine forms.

Luidia avicularia Fisher.

Luidia avicularia, Fisher, 1913*a*, p. 203 ; 1919, p. 172, pl. xliii, fig. 1, pl. xliv, fig. 2, pl. xlvi, figs. 2, 2*a-c*.

Occurrence :

St. 27, Gulf of Aden, 37–91 m., sand and shell ; 1 specimen.

Distribution.—Philippines ; Gulf of Aden.

Remarks.—Two arms are entire but both are in process of regeneration ; r 16 mm. The abactinal paxillæ are borne on a high rounded arch, beyond which the infero-marginals scarcely project. Down the centre of each arm is a band of paxillæ in six or seven irregular rows. The paxillæ are small and beset with short round-tipped spinelets, two to nine

in the centre, and ten to seventeen rather finer ones peripherally. As far as can be made out there are no paxillar pedicellariæ.

On either side of this median band there are four regular rows of larger paxillæ, the outermost, which is the supero-marginal row, being the smallest. Springing from the centre of nearly every plate of the innermost row is a tapering pointed spinelet, nearly 1·5 mm. in length. Around it are about two rings of spinelets. A few of the paxillæ of the next row bear a similar enlarged central spinelet, but on the two outermost rows a spinelet of the dimensions of those on the two inner rows is never found, though often one spinelet in the centre is a little larger than its neighbours.

The infero-marginal plates bear four or five tapering pointed slightly curved spines, the upper three subequal, about 3 mm. long, the lower one or two somewhat shorter. The edges of the plates have a sparse covering of small, rather broad spinelets.

The adambulacral armature is variable. There is always a flattened upcurved pointed spine projecting across the furrow but never apparently a pedicellaria beneath it. A stout, upright conical spine stands above the furrow spine, and behind it is a similar but smaller spine and then one of the long two-jawed pedicellariæ. One or both may be replaced by a pedicellaria.

This specimen is to some extent intermediate between the Andaman species *L. integra* Koehler and the Philippine species *L. avicularia* Fisher, both of which are founded on a single specimen. It agrees with the former in lacking abactinal pedicellaria, but on account of the occurrence of elongated spinelets on the dorso-lateral paxillæ it is here referred to the species *L. avicularia*.

Immature *Luidiidæ*.

Small forms, all with more than five arms, were taken at the following stations:

St. 24,	Gulf of Aden, 73–200 m.;	1 specimen.
St. 27,	,, ,, 37–91 m.;	1 ,,
St. 43,	S. Arabian Coast, 83–100 m.;	1 ,,
St. 119,	Zanzibar area, 1207–1463 m.;	1 ,,
St. MB. IIc,	S. Arabian Coast, 29 m.;	1 ,,

Family Benthopectinidæ.

Genus *Pectinaster* Perrier.

The table below shows the distribution of the species which are referred to this genus. Sladen's species *Pontaster forcipatus*, *Pontaster forcipatus* var. *echinita* and *Pontaster mimicus* are referred to the genus *Pectinaster* by Perrier (1894, p. 279). Ludwig, in his revision of the family (1910) ranks *Pontaster forcipatus* Sladen and *Pontaster venustus* Sladen as synonyms of *Pectinaster filholi* Perrier, and also transfers to the present genus *Archaster echinulatus* Perrier, *Pontaster pristinus* Sladen, *Pontaster hispidus* Alcock & Wood-Mason, *Pontaster cribrellum* Alcock, and *Cheiraster agassizii* Ludwig. Verrill (1915) transfers *Archaster echinulatus* Perrier to the genus *Cheiraster*, and *Pontaster oligoporus* Perrier and *Cheiraster vincenti* Perrier to the present genus.

Ocean.	Species. (Synonyms in brackets.)	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*filholi* Perrier	Perrier, 1894	Many	4	Cape Verde, Azores	1258–2333 m.	Grey or grey-green mud.
		Clark, 1923	11	4	Cape of Good Hope	1422–1828 m.	..
	(*venustus* Sladen)	Sladen, 1889	..	2	Azores	1645–3702 m.	Pteropod ooze, globigerina ooze.
		Perrier, 1894	51	4	,,	1258–2200 m.	Sand, greenish mud, grey mud.
	(*forcipatus* Sladen)	Sladen, 1889	..	4	N. America	2260–3108 m.	Blue mud.
	(*forcipatus* var. *echinata* Sladen)	,, ,,	..	1	Between Marion and Crozet Is.	2513 m.	Globigerina ooze.
	pristinus (Sladen)	,, ,,	..	1	S. America	3748 m.	Blue mud.
	oligoporus (Perrier)	Perrier, 1894	1	1	West Indies	270 m.	..
		Verrill, 1915	1	1	,, ,,	270 m.	Ooze and sand.
	vincenti (Perrier)	Perrier, 1894	..	..	,, ,,	..	..
		Verrill, 1915	6	1	,, ,,	166 m.	..
	mixtus Verrill	,, ,,	Many		,, ,,	151–434 m.	..
	gracilis Verrill	,, ,,	"Very common"		,, ,,	126–540 m.	..
	dispar Verrill	,, ,,	1	1	,, ,,	..	..
Pacific	*agassizii* (Ludwig)	Ludwig, 1905	596	9	Gulf of Panama, Gulf of California, Galapagos Is.	1271–2323 m.	Globigerina ooze and mud.
		Clark, 1913	96	7	S. California	811–1990 m.	..
		,, 1920	11	1	Gulf of Panama	1393 m.	Green sand.
		,, 1923	44	..	S. California	792 m.	..
	agassizii subsp. *evoplus* Fisher	Fisher, 1911	227	3	,,	1798–1935 m.	Grey and green mud.
	robustus A. H. Clark	Clark, 1917	1	1	Off Chile	2415 m.	..
Eastern Archipelago	*mimicus* (Sladen)	Sladen, 1889	..	1	Arafura Sea	1463 m.	Green mud.
		Fisher, 1919	13	7	Flores Sea, Macassar Strait, Celebes	1264–1995 m.	Grey and green mud.
	mimicus subsp. *palawanensis* Fisher	,, ,,	6	1	Palawan Passage	1334 m.	Coral sand.
	mimicus subsp. *malayanus* Döderlein	Döderlein, 1921	14	6	Celebes	1018–1914 m.	Grey and green mud.
	hylacanthus Fisher	Fisher, 1913*a*	34	4	Philippines	700–800 m.	,, ,, sand.
	mimicus subsp. *hylacanthus* Döderlein	Döderlein, 1921	11	4	Moluccas	724–924 m.	Grey and blue mud.
Indian	*mimicus* (Sladen)	Alcock, 1893	..	..	Laccadive Sea	1828 m.	Olive mud.
	hispidus (Alcock & Wood-Mason)	Alcock and Wood-Mason, 1891	..	..	,, ,,	1828 m.	Green mud.
		Koehler, 1909	8	7	Arabian Sea to Gulf of Oman	877–2473 m.	..
	cribrellum (Alcock)	Alcock, 1893	..	..	Laccadive Sea	2192 m.	Coral and globigerina ooze.

Pectinaster agassizii (Ludwig).

Cheiraster agassizii, Ludwig, 1905, p. 1, pl. i, figs. 3, 4, pl. ii, figs. 5–12, pl. xvi, figs. 81–84.
Pectinaster agassizii, Ludwig, 1910, p. 449.

Occurrence :

St. 185, Gulf of Aden, 2001 m., green mud ; 2 specimens.

Distribution.—Gulf of Panama, Gulf of California, Galapagos Is. ; Gulf of Aden.

Description.—The measurements of the two specimens are : larger, R 119 mm., r 17 mm., R/r 7 ; smaller, r 14 mm. The *abactinal paxillæ* are of two kinds, the smaller uniformly granular, the larger with a ring of granules surrounding a central spinelet. In the smaller specimen the abactinal surface is in better condition, and these spinelets can be detected everywhere, though they become smaller as the tip of the ray is approached and are not visible to the naked eye much beyond the middle of the ray.

The *papularia* are oval, the radial axis a little longer than the tangential. Each contains forty to fifty pores.

The larger specimen has thirty-three *supero-marginal plates*, which are small, confined to the side of the ray, and armed with a robust pointed spine 4 to 5 mm. long. The first two or three plates are closely covered by fine elongate granules ; on succeeding plates the granules become scarcer, and a small area below the spine is bare.

On the lateral face of each *infero-marginal plate* there is a spine similar to that of the supero-marginal above, and on the actinal face stands a second spine like it but between a third and one-half the size. The granulation is coarser and more uniform than that of the supero-marginal plates, and about the base of the larger spines there are often two or three spinelets.

The *actinal intermediate areas* extend to the sixth infero-marginal plate. The plates are beset with short cylindrical spinelets, round-tipped or pointed, about 0·5 mm. in length. Springing from the centre of some of the plates is a tapering pointed spine which may attain a length of 2 mm., though usually it is less. Fasciolar pedicellariæ are numerous.

Seven *adambulacral furrow spines* are set on an angular border. The central spine is the longest, and there is a progressive decrease in size to the outermost, which is barely half as long. Four or five small spines along the proximal border of the plate appear to continue the furrow series. There is a robust conical spine about 3 mm. long in the centre of the actinal surface of each plate. Sixteen adambulacral plates correspond to ten infero-marginals.

From the inner corner of each *mouth plate* two stout tapering spines, of which the inner is a trifle the larger, project into the mouth cavity. Projecting into the furrow are six smaller spines which show a regular decrease in size from the proximal to the distal end of the series. Two large conical spines stand on the actinal surface of each plate, together with a number of small cylindrical spines, of which a series of four lie parallel with the furrow, while eight in two irregular rows lie parallel with the median suture.

Affinities.—A doubt as to whether these two specimens have been correctly identified will persist until they have been compared side by side with an example of *P. agassizii*. Both, however, agree closely with Ludwig's description, and the only difference is that, whereas the present examples have but one supero-marginal spine, specimens of smaller dimensions from the East Pacific have two. I do not think this character affords sufficient grounds for separation.

The most closely related species is *P. mimicus* Sladen. This form has the abactinal spinelets confined to a central band and a uniform actinal intermediate granulation. It may be separated on yet a third character, not mentioned in Ludwig's key, namely, the smaller number of papulæ.

Pectinaster agassizii granuliferus subsp. n.

Occurrence :

St. 26, Gulf of Aden, 2312 m., soft grey white mud ; 3 specimens.

One specimen is small (R 33 mm.). The other two are well-grown and have the following characters : (i) R 158 mm., r 20 mm., R/r 7·9, number of papulæ 40, number of supero-marginal plates 45 ; (ii) r 8·5 mm., number of papulæ 25. The specimens are very close to *P. agassizii* Ludwig, of which two examples were obtained at St. 185, and the description is therefore given in the form of a comparison.

Diagnosis.—Close to *P. agassizii*, differing in three particulars : abactinal spinelets confined to a central band ; abactinal and intra-marginal pedicellariæ present ; granules instead of spinelets on the actinal plates.

Description.—On the *abactinal surface* an occasional pectinate pedicellaria is found, and the paxillæ with central spinelets are absent from a band some 2 mm. broad adjoining the supero-marginal plates. In *P. agassizii* these paxillæ occur all over the abactinal surface.

In the larger specimen the proximal *supero-marginal plates* bear two spines, the longer measuring 4 mm., the shorter 3 mm. The granulation is similar to that of *P. agassizii* in distribution but it is shorter. Whereas the granules of *P. agassizii* are definitely capillary, those of this subspecies are papilliform. Pedicellariæ are found between the first two or three supero-marginal and infero-marginal plates. The *infero-marginals* are similar to those of *P. agassizii*, but in the larger specimen they bear three, instead of two, spines.

The pedicellariæ of the *actinal intermediate areas* are similar to those of *P. agassizii* but rather more numerous. The plates are bordered by rather few short hemispherical or pointed granules, and on account of this the actinal surface has a facies distinctly unlike that of *P. agassizii*, in which the armature is more abundant and spiniform. This subspecies has, however, an elongate conical spine in the centre of many of the plates.

The furrow spines of the *adambulacral plates* are arranged as in *P. agassizii* but they are a little shorter, and the series along the proximal border of the plate is granuliform instead of spiniform.

Affinities.—The subspecies *granuliferus* differs from *P. agassizii evoplus* Fisher in the restriction of the abactinal spinelets, in the granular actinal intermediate armature and in having fewer pores. The first two characters suggest the group of species to which *P. mimicus* Sladen, *P. filholi* Perrier and *P. hispidus* Alcock & Wood Mason belong, but all these have a uniform actinal intermediate armature and a relatively small number of pores.

Genus *Benthopecten* Verrill.

Ludwig (1910) in his revision of the *Notomyota* retains *Benthopecten* Verrill and *Pararchaster* Sladen as distinct genera. Fisher (1911, p. 143) points out certain difficulties which arise if this step is taken and unites the two genera. The distribution of the genus *Benthopecten* in the extended sense demanded by Fisher is as follows :

Occan.	Species. (Synonyms in brackets.)	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*spinosus* Verrill	Verrill, 1899, 1915	Many records		Coast of U.S.A., Gulf of Mexico	1300–3600 m.	..
		Grieg, 1932	18	3	N. Atlantic	1100–1853 m.	..
		Mortensen, ?	..	..	S. Iceland	2094 m.	..
	(*armatus* Sladen)	Sladen, 1889	..	3	Nova Scotia, New Jersey, Portugal	2284–2466 m.	Blue mud.
		Farran, 1912	30	1	Ireland	1744 m.	Ooze.
	(*semisquamatus* var. *occidentalis* Sladen)	Sladen, 1889	1	1	Coast of U.S.A.	3108 or 2266 m.	Blue mud.
	(*fischeri* Perrier)	Perrier, 1894	1	1	Coast of Africa	1056–1435 m.	..
	spinosissimus (Sladen)	Sladen, 1889	1	1	Ascension	756 m.	Volcanic mud.
	simplex (Perrier)	Perrier, 1881	1	1	Gulf of Mexico	2420 m.	..
	folini (Perrier)	,, 1894	10	3	Coast of Africa	2300 m.	..
Southern	*antarcticus* (Sladen)	Sladen, 1889	2	1	Challenger's most southern dredging	3000 m.	Blue mud.
	pedicifer (Sladen)	,, ,,	..	2	Crozet Is.	2925 m.	Diatom ooze.
					Aghulhas bank	3473 m.	Globigerina ooze.
Pacific	*acanthonotus* Fisher	Fisher, 1905	7	2	S. California	1794–1900 m.	Mud.
	mutabilis Fisher	,, 1910	8	1	British Columbia	2876 m.	Globigerina ooze.
	claviger Fisher	,, ,,	16	4	Bering Sea to Oregon	1794–1900 m.	Green mud or ooze.
	pectinifer (Ludwig)	Ludwig, 1905	37	3	Galapagos, Gulf of Panama, Gulf of California	1571–2323 m.	Globigerina ooze, brown mud
	cognatus (Ludwig)	,, ,,	1	1	Gulf of Panama	3035 m.	Sand.
	spinuliger (Ludwig)	,, ,,	25	4	Galapagos Is., Cocos Is., Gulf of Panama	1618–2323 m.	Globigerina ooze.
Eastern Archipelago	*moluccanus* Fisher	Fisher, 1913*a*	9	2	Molucca Passage	417–435 m.	Grey sand and mud.
	polyctenius Fisher	,, ,,	12	2	Celebes	1475 m.	..
	styracius Fisher	,, ,,	2	1	Macassar Strait	1645 m.	Grey mud.
	semisquamatus subsp. *celebensis* Döderlein	Döderlein, 1921	9	4	Celebes	1688–3437 m.	Green and grey mud
Indian	*huddlestonii* (Alcock)	Alcock, 1893	..	..	Bay of Bengal	2778 m.	Globigerina ooze.
	violaceus (Alcock)	,, ,,	..	..	Laccadive Sea	2193 m.	Coral and globigerina ooze.
	indicus (Koehler)	Koehler, 1909	1	1	S. of Ceylon	834–1076 m.	..
Indian to Pacific	*semisquamatus* (Sladen)	Sladen, 1889	..	2	Japan	1875–1114 m.	Blue mud, green mud
		Alcock and Wood-Mason, 1891	1	1	Bay of Bengal	3041 m.	Globigerina ooze.

Benthopecten heteracanthus sp. n.

Occurrence :

St. 26, Gulf of Aden (African coast), 2312 m., soft grey white mud ; 1 specimen.

Diagnosis.—R/r 8·4. Abactinal plates with one to four papilliform spinelets ; spines occurring only in two rings, one of five around the anus, the other of ten some 7 mm. from the first and on the madreporite. Papulæ extending to about sixth supero-marginal plate. Supero-marginals confined to side-wall of disk and ray ; armed with a single robust tapering pointed spine, encircled by three or four spinelets ; five unpaired interradial supero-marginals, each armed with one very large spine and three accessory spines. Infero-marginals almost directly below supero-marginals ; bearing two spines ; pedicellariæ between infero-marginals almost to tip of ray. Actinal interradial areas small, with usually four pedicellariæ and a few spinelets. Adambulacral plates with seven to eleven small clavate furrow spines and two larger actinal spines. Mouth plates with two spines projecting into mouth cavity, four projecting into furrow and three spines on actinal surface.

Description.—R 210 mm., r 25 mm. In the centre of the disk there is a ring of five spines, each 4 mm. long, slightly tapering and rounded at the tip. Ten similar spines on the radii and interradii stand at a distance of 7 mm. from this central group and, except for two spines on the edge of the madreporite, are the only spines found on the abactinal surface. The remaining plates bear projections which are little more than papillæ, not quite 1 mm. in length. Most plates bear but a single papilla, but two or three, or even four, occur on some. The madreporite lies on an interradius a little nearer the edge than the centre of the disk. Papulæ are present on that portion of the disk which lies without the outer ring of spines, and extend down the rays in two attenuating bands as far as the level of the fifth or sixth supero-marginal plate. There are no abactinal pedicellariæ.

The *supero-marginal plates* number about fifty. They are confined to the side of the disk and ray and are all longer than high. Each bears a tapering pointed spine, the longest (on the sixth plate) measuring 13 mm. Near the proximal edge of each plate there are sometimes one or two minute spinelets, and round the base of the boss on which the main spine stands there is always a ring of slightly larger spinelets, 1 to 2 mm. long On the first two or three plates one of these encircling spinelets reaches a length of 5 mm. and may be ranked as an accessory spine. An unpaired plate is present in each interradius, and bears one spine, 18 mm. long, and three accessory spines, 5 to 6 mm. long.

The *infero-marginals* encroach very little on to the actinal surface and lie almost directly beneath the supero-marginals, which they resemble in size. Each bears two spines, one below the other, the upper nearly as long as, but finer than, the corresponding supero-marginal spine, the lower between one-half and two-thirds the size of the upper. A few minute spinelets may occur at random on the surface of the plate, but there is always a regular row of five or six along the border adjacent to the adambulacral plates. Fasciolar pedicellariæ occur between adjacent infero-marginals and can be traced almost to the tip of the ray. Ten infero-marginals correspond to seventeen or eighteen adambulacral plates.

The *actinal intermediate areas* are small and the outline of the plates is obscured by membrane. Two, or in one case three, fasciolar pedicellariæ stand on either side of the interradial line. A few spinelets are also present.

The furrow margins of the *adambulacral plates* are rounded and those near the mouth bear seven or eight spines, which are slightly clavate and small, the largest measuring little more than 1 mm. in length. Three subequal spines stand close together and occupy the centre of the margin, while a fourth, also of much the same size, stands a little apart distally. On either side of this central group are found one or two smaller spines spaced at intervals nearly equal to their length. On the outer half of the ray the total number of spines is eleven. There is a central group of six with two or three smaller spines on either side, but owing to the increase in numbers these are not so far apart as on the proximal plates. The actinal surface of the plates supports two, usually equal, tapering pointed spines, 4 to 5 mm. in length.

The free edge of the *mouth plates* bears six spines. Two of these project into the mouth cavity. They are cylindrical and rounded at the tip ; the inner, which is a trifle the larger, is 4 mm. long. The remaining four spines project into the furrow and are similar to the furrow spines of the adambulacral plates. The largest is nearest the mouth and the remainder show a progressive decrease in size. On the actinal surface of the plate there are three spines similar to the two projecting into the mouth cavity but smaller. They show a regular decrease in size from the proximal to the distal end of the series.

Affinities.—The affinities of this species lie within a complex of three, comprising *B. violaceus* (Alcock), *B. styracius* Fisher and *B. polyctenius* Fisher. The species are compared in the table below :

	Spine on unpaired SMP.	Number of spinelets on abact. plates.	Accessory spines on SMPs.	Abactinal pedicellariæ.	Limit of papulæ.	Extent of pedicellariæ on IMPs.	Number of act. int. pedicellariæ.	Number of furrow spines.	Number of spines per IMP.	Number of adamb. plates = 10 IMPs.
B. heteracanthus .	Very large	1–4	Present	Absent	6th SMP.	Far along ray	2	7–11	2	17–18
B. violaceus . .	Large	2–4	,,	,,	2nd SMP.	To 4th IMP.	2	7–8	2	24
B. styracius . .	Very large	1–2	Absent	Present	3rd SMP.	Far along ray	2	7–8	2	19–22
B. polyctenius .	4 equal	5–8	Present	,,	4th SMP.	Ditto	8–12	9–14	2	20

Thus *B. heteracanthus* differs from *B. violaceus* in the greater extent of the papulæ and infero-marginal pedicellariæ, more numerous furrow spines, less numerous abactinal spinelets, fewer adambulacral plates to ten infero-marginals, and a larger spine on the unpaired supero-marginal. It is perhaps closest to *B. styracius*, from which it differs in the absence of abactinal pedicellariæ, the greater extent of the papulæ, more numerous furrow spines and fewer adambulacral plates to ten infero-marginals. As Fisher (1919, p. 213) points out, the type of *B. violaceus* is probably but half-grown, and in the adult condition would be likely to have more numerous pedicellariæ, more numerous abactinal spinelets and more numerous furrow spines. In one of his Pacific species, *B. acanthonotus*, Fisher (1911, p. 145) records variability in the extent of the papulæ areas. It is probable,

therefore, that the four species stand closer than is indicated by a comparison of the characters of the very meagre number of examples at present known. For the moment, however, there is not enough evidence to regard them as anything but distinct species.

Immature *Benthopectinidæ*.

St. 107, Zanzibar area, 421–457 m. ; *Luidiaster* sp., 1 specimen.
St. 118, ,, ,, 1789 m. : *Pectinaster* sp., 1 specimen.
St. 123, ,, ,, 256–366 m. ; *Luidiaster* sp., 1 specimen.

Family Goniasteridæ.

Sub-family Pseudarchasterinæ.

Genus *Pseudarchaster* Sladen.

The species of this genus are distributed as follows :

Ocean.	Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic .	*annectens* (Perrier) .	Perrier, 1894	1	1	N. coast of S. America	900 m.	..
		Koehler, 1895	1	1	Coast of France	1410 m.	..
		Perrier, 1896	5	1	,, ,,	1384 m.	Sand and pteropods.
		Koehler, 1909*a*	4	4	Azores	1550–1900 m.	Globigerina ooze ; mud and sand ; sand and rock
	hystrix (Perrier) . .	Perrier, 1894	1	1	Coast of Morocco	840 m.	Yellow mud.
	fallax (Perrier) . .	,, 1885	17	4	Azores	1440–2220 m.	Grey mud.
		Koehler, 1909*a*	2	2	,,	1165–1385 m.	Sandy mud.
		Grieg, 1932	2	1	Newfoundland	1100 m.	..
	necator (Perrier) . .	Perrier, 1894	1	1	Azores	1275 m.	Grey mud.
		Koehler, 1909*a*	1	1	,,	1900 m.	Globigerina ooze.
	hispidus Verrill . .	Verrill, 1899	1	1	West Indies	1097 m.	..
	granuliferus Verrill .	,, ,,	1	1	,, ,,	..	..
	concinnus Verrill .	,, 1895, 1899	..	3	American coast	2138–3203 m.	..
	ordinatus Verrill .	,, 1899	..	2	Gulf of Mexico	583–603 m.	..
	gracilis (Sladen) . .	Sladen, 1889	..	1	Azores	1800 m.	Volcanic mud.
	aphrodite (Perrier) .	Perrier, 1894	..	..	Coast of Sahara	1090 m.	..
	æquabile (Koehler) .	Koehler, 1909*a*	1	1	Azores	1900 m.	Globigerina ooze.
	eminens (Koehler) .	,, ,,	4	3	,,	1095–1940 m.	Sandy mud ; mud and sand ; volcanic sand.

Ocean.	Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic —*cont.*	*marginatum* (Koehler)	Koehler, 1909*a*	1	1	Azores.	1805 m.	Sandy mud.
	parelii (Düben & Koren)	N. Atlantic, Europe to America.			Many records, *see* Fisher, 1911, Goto, 1914.		
Pacific	*intermedius* Sladen	N. Pacific, Asia	,,		,, ,,		,,
	discus Sladen	Sladen, 1889	..	1	Patagonia	267 m.	Blue mud.
	patagonicus (Perrier)	Perrier, 1891	1	1	,,	283 m.	..
	pusillus Fisher	Fisher, 1904, 1911	461	20	California	96–694 m.	Various.
		Clark, 1913, 1923	48	1	S. California	511 m.	..
	dissonus Fisher	Fisher, 1911	5	3	Oregon to Bering Sea	1436–1944 m.	Green mud.
	pulcher Ludwig	Ludwig, 1905	4	3	Galapagos Is.	702–1618 m.	Mud, sand, globigerina ooze.
	verrilli Ludwig	,, ,,	1	1	Gulf of Panama	998 m.	Blue mud.
	myobrachius Fisher	Fisher, 1906	3	2	Hawaii	779–1234 m.	Sand and rock.
	pretiosus Döderlein	Döderlein, 1902	..	..	Japan	20–30 m.	..
		Goto, 1914	13	4	,,	20–480 m.	..
	pectinifer Ludwig	Ludwig, 1905	1	1	Gulf of Panama	1865 m.	Green mud.
		Clark, 1913	1	1	S. California	1164 m.	..
		,, 1920	2	1	Coast of Peru	1864 m.	Dark brown mud.
		Döderlein, 1924	2	2	Eastern Archipelago	724–1018 m.	Grey mud.
	alascensis Fisher, 1904 = *parelii alascensis* Fisher, 1911	Fisher, 1911	9	6	Alaska	122–1915 m.	Rocks and coarse sand, rocks, mud, green mud.
	abnormale (Bell)	Benham, 1900, 1909	..	..	New Zealand	20–50 m.	..
	huttoni (Farquhar)	Farquhar, 1897	..	..	,, ,,	..	..
	boardmani Livingstone	Livingstone, 1934	4	2	Australia	135–162 m.	Sand and clay.
Eastern Archipelago	*oligoporus* Fisher	Fisher, 1913	3	2	Celebes	1992 m.	Green and grey mud.
	spatuliger Mortensen	Mortensen, 1934	..	..	Hong Kong	..	..
Indian	*mozaicus* (Alcock & Wood-Mason)	A. & W.-M., 1891	..	..	Andaman Sea	352–400 m.	Green mud.
		Koehler, 1909	15	8	,, Bay of Bengal, Gulf of Oman S. India	584–1794 m.	..
	roseus (Alcock)	Alcock, 1893	..	..	Laccadive Sea	1352 m.	Coral mud.
	brachyactis Clark	Clark, 1925	..	..	Cape of Good Hope	365–731 m.	Green sand.
	tessellatus Sladen	Sladen, 1889	..	1	,, ,,	..	..
		Clark, 1925	4	..	,, ,,	155 m.	Green sand.
		Mortensen, 1933	Many		,, ,,	170–320 m.	..
Pacific to Indian	*jordani* Fisher	Fisher, 1906	2	1	Hawaii	685 m.	Fine white sand.
		,, 1913	54	4	Borneo and Moluccas	785–1627 m.	Green and grey mud.
		Koehler, 1909	..	..	S. India Arabian Sea	814–1982 m.	..

Pseudarchaster mozaicus Alcock & Wood-Mason. (Pl. II, figs. 1 and 10 ; Text-fig. 2.)

Pseudarchaster mozaicus, Alcock & Wood-Mason, 1891, p. 432 ; Alcock, 1893, p. 85.
Astrogonium mozaicum, Koehler, 1909, p. 50, pl. i, fig. 3.

Occurrence :

St. 108, Zanzibar area, 786 m., grey mud ; 1 specimen.
St. 115, ,, ,, 640–658 m. ; 1 specimen.
St. 122, ,, ,, 732 m., grey green mud ; 2 specimens.

Distribution.—Andaman Sea, Gulf of Oman. Bay of Bengal : Zanzibar area ; 352 to 1794 m.

Description :

R . .	94 .	80 .	72 .	60 mm.
r . .	27 .	23 .	20 .	17 ,,
R/r . .	3·4 .	3·5 .	3·6 .	3·5

The following description is taken from the largest specimen. The body is flat. The arms taper and are pointed at the tip. The abactinal paxillæ lie in regular radial and transverse rows. The following table shows the dimensions of the arms and the number of paxillæ at the level of successive supero-marginal plates :

	SMP. No.				
	4.	8.	16.	24.	
Breadth of arm . .	26 .	17 .	12 .	6	mm.
Breadth of paxillar area .	15 .	7 .	4 .	2	,,
Number of paxillæ . .	11 .	9 .	7 .	2	

The *carinal plates* are round with a diameter of 1 mm. or a little more. Each is covered with granules, of which the central are large, hemispherical and well spaced, while those of a peripheral series are less than half the size, slightly clavate and alternating with the central series. A few granules are intermediate in size, but appear to belong to the peripheral series. If this be the correct interpretation, the arrangement is eight to fourteen central granules and twenty to twenty-five peripheral granules.

The *supero-marginals* are thirty-four in number. They form a broad border to the paxillar area and curve round to meet the infero-marginals, the curve becoming more abrupt towards the outer edge of the plate. The breadth in the interradius is between two-and-a-half and three times the length. The length increases slightly up to the sixth or eighth plate while the breadth decreases uniformly to the tip of the ray, though it remains the greater dimension throughout as is shown in the following table :

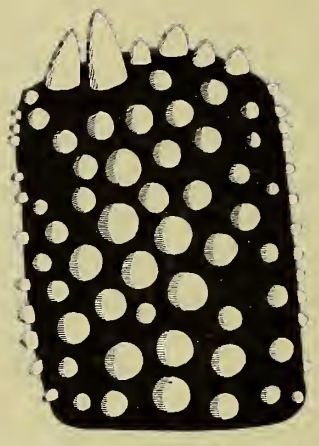
	Plate No.				
	1.	4.	8.	16.	
Breadth	6 .	5·5 .	5 .	4	mm.
Length	2 .	2·5 .	4 .	2	,,

The plates are beset with five to eight irregular rows of well-spaced granules which become larger towards the centre of the plate. At the outer border of each plate four or

five of the granules are conical, and one or two are elongated and project as conspicuous blunt conical spinelets about 1 mm. long (Text-fig. 2).

The *infero-marginals* correspond to the supero-marginals and like them decrease regularly in breadth from the interradius to the tip of the ray, while the length shows a slight increase up to the sixth or eighth plate. There are six or seven rows of pointed spinelets and each row has larger spinelets than the row outside it. About half-a-dozen spinelets in each of the two innermost rows are longer than all the rest and reach a length of 1·5 mm.

The *actinal intermediate areas* reach the sixth or seventh infero-marginal. The limits of the plates are obscured by membrane, but they are marked by pointed granules,



Text-fig. 2.—*Pseudarchaster mozaicus* Alcock & Wood-Mason. (From St. 122.) 8th supero-marginal plate × 8.

and in the centre of each plate there are one, or occasionally two, spinelets whose length, 2 mm., is four to five times that of the peripheral granules.

On the angular furrow margin of the *adambulacral plates* there are six to eight tapering pointed spines, and on the actinal surface there are two rows of five or six spines, which are usually all shorter than the furrow spines, though sometimes one to three of the inner row may be of the same length. Proximally there are about eight fasciolar pedicellariæ.

Colour.—Paxillar area, vinaceous lilac; marginal plates and actinal surface, pale flesh colour.

Affinities.—I have been able to compare these specimens with an example of *P. mozaicus* from the Indian Museum and I have no hesitation in referring them to this species, although there are some small details, tabulated below, in which they differ from it and approach *P. jordani* Fisher, a species typically without supero-marginal armature:

Species.	Granulation of carinal paxillæ.		Number of rows of granules on SMPs.	Number of furrow spines.	Number of adamb. act. spines.
	Central.	Peripheral.			
P. mozaicus	5–7	20–25	About 5	5	8
P. jordani	15–18	10–12	7–8	6–7	12–20
P. mozaicus, Zanzibar specimens	8–14	20–25	5–8	6–8	10–12

Pseudarchaster diversigranulatus sp. n. (Text-fig. 3.)

Occurrence :

St. 26, Gulf of Aden, 2312 m., soft grey-white mud ; 2 specimens.

St. 59, Ras el Hadd, Arabia, 1948 m., soft green mud ; 1 specimen.

Diagnosis.—Arms tapering, pointed. Paxillar area large ; paxillæ in regular radial and transverse series ; large, with round clavate central granules and a peripheral series of only slightly smaller, flattened, subtruncate granules. Supero-marginal plates narrow ; with characteristic granules, those along adjacent edges forming a fasciolar apparatus, those in the centre hemispherical, two to four much enlarged, those near the outer border conical, one or two enlarged. Infero-marginals corresponding to supero-marginals ; armed with rows of fine pointed spinelets, those of the middle rows longest. Actinal intermediate areas large ; plates beset with bluntly pointed spinelets of which two or three in the centre are elongated. Adambulacral plates with furrow series of six or seven short round-tipped spines on convex margin ; remaining margins of plate with about seven similar smaller spines ; centre occupied by three pointed spines which may be longer than those of furrow series.

Description.—St. 59, R 93 mm., r 25 mm., R/r 3·7 ; St. 26, R 52 mm., r 16 mm., R/r 3·3 ; R 50 mm., r 15 mm., R/r 3·3.

The following table shows the breadth of the arm and the paxillar area, and the number of paxillæ at the level of successive supero-marginal plates :

	SMP. No.				
	4.	8.	16.	24.	
Breadth of arm	23	17	13	8	mm.
,, of paxillar area	13	9	5	4	,,
Number of paxillæ	17	15	9	5	

The above table and the following description are taken from the largest specimen. The paxillæ are arranged in regular radial and transverse rows, and are large, for the diameter of those in the carinal row is about 2 mm. The top of such a paxilla is hemispherical, and on it there are fourteen to sixteen large round well-spaced clavate granules, while round the rim runs a series of about twenty granules which are of almost the same size as those in the centre but differ in being rather flattened and subtruncate. The paxillæ of the ray are not elongated. Papulæ extend about two-thirds of the way down the arm.

The *supero-marginal plates* number forty. The breadth of the first plate is a little over twice the length ; of the next five or six plates each is a little broader than the one before, the next ten or twelve plates are of the same breadth and the remainder decrease uniformly in breadth to the tip of the ray ; the length increases up to the ninth or tenth plate and then decreases. Dimensions :

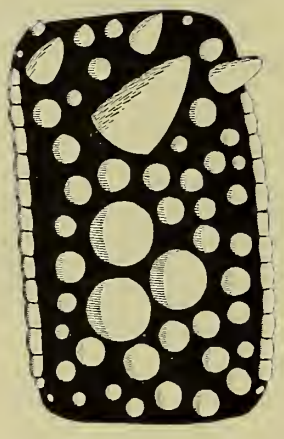
	Plate No.					
	1.	4.	8.	16.	24.	
Breadth	4·5	5	4	4	2	mm.
Length	2	2·5	3	2	1·5	mm.

The edge of each supero-marginal bears a series of small subtruncate granules which are apposed to those of the neighbouring plates in such a manner as to form a fasciolar apparatus. The rest of the plate is occupied by about four irregular rows of hemispherical granules of which two to four are considerably larger and more protuberant than the

rest. Near the outer border of the plate, just above the infero-marginal, the granules are pointed and one or two stand out as coarse conical spinelets. These spinelets are most conspicuous about half-way down the ray (Text-fig. 3).

The *infero-marginal plates* correspond exactly with the supero-marginals. The plates are separated by fasciolar grooves, and the surface is beset with about six rows of pointed spinelets. Those of the outer row are the shortest, those of the inner row, with a length of about 1 mm., the longest.

The *actinal intermediate areas* extend to the eleventh infero-marginal. The boundaries of the plates are obscured by membrane, but each is apparently armed with twelve to fifteen short bluntly pointed spinelets. Two or three of these stand in the centre of the plate and are longer than the rest, which are set round the edge. Of the central spines one is often a trifle longer than the others and may be 1·5 mm. long. Between the proximal half-dozen plates of the innermost chevron there is a fasciolar pedicellaria.



Text-fig. 3.—*Pseudarchaster diversigranulatus* sp. n. (From St. 59.) 8th supero-marginal plate × 8.

The *adambulacral plates* bear six or seven short round-tipped furrow spines, about 1 mm. long, on a regularly convex margin. The furrow series appears to be continued right round the plate by some seven similar but rather smaller spines. In the centre stand three pointed spines, some or all of which may be longer than the furrow spines.

Remarks.—The two smaller forms from St. 26 appear to belong to the same species. They show the enlarged supero-marginal granules, but those on the outer edge of the plates are not pointed.

Affinities.—The largest specimen of *P. diversigranulatus* is of almost exactly the same size as the largest *P. mozaicus*. Comparison reveals a number of small differences. The upper tables on pp. 357 and 359 show that the shape of the arm is different in the two species, and that in *P. diversigranulatus* each radial row of paxillæ extends considerably farther down the arm than in *P. mozaicus*. The paxillæ of *P. diversigranulatus* are larger, more uniformly granulated and do not become elongated down the rays. Of the two species *P. diversigranulatus* has narrower supero-marginal plates* (*cf.* tables, pp. 357 and 359), and their granulation is characteristic. There are also conspicuous differences in the armature of the infero-marginal, actinal intermediate and adambulacral plates of the two species.

* Text-figs. 2 and 3 are not drawn from the same angle. The supero-marginal of *P. diversigranulatus* (Text-fig. 3) has been drawn somewhat from the side and so appears to be broader than the corresponding plate of *P. mozaicus* (Text-fig. 2).

Genus *Paragonaster* Sladen.

Distribution.—The records of the occurrence of the various species of this genus are shown in the following table :

Ocean.	Species. (Synonyms in brackets.)	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic .	*subtilis* (Perrier) . .	Perrier, 1881, 1884, 1894	3	3	Gulf of Mexico, Cape Verde Is., Azores	3530 m. 3655 m. 2995 m.	..
		Koehler, 1909*a*	7	4	,, Cape Verde Is.	3890–4261 m.	White mud, sandy mud, globigerina ooze.
		Grieg, 1932	3	1	Coast of Spain	4700 m.	Yellow sand.
	(*cylindratus* Sladen) .	Sladen, 1889	1	1	Cape Verde Is.	2382 m.	Globigerina ooze.
	(*elongatum* Perrier) .	Perrier, 1884	3	3	Azores	2996–4060 m.	White clay, pumice.
	(*strictus* Perrier) .	,, 1894	3	1	Canary Is.	3655 m.	Grey mud.
	(*formosus* Verrill) .	Verrill, 1884, 1895	..	15	Coast of New England	2512–3690 m.	..
Eastern Archipelago	*ctenipes* Sladen . .	Sladen, 1889	..	1	Banda Sea	255 m	Blue mud.
	ctenipes var. *hypacanthus* Fisher	Fisher, 1913, 1919	34	11	Philippines	207–313 m	Green mud; grey mud; sand and mud; globigerina ooze.
		Döderlein, 1924	3	2	Timor Sea	216–310 m.	Grey mud; coral sand.
	stenostichus Fisher .	Fisher, 1913, 1919	8	2	Philippines	220–360 m.	Sand and broken shell; mud and sand.
		Döderlein, 1924	1	1	Kei Island	310 m.	Grey mud.
Indian .	*tenuiradiis* Alcock .	Alcock, 1893	..	..	Bay of Bengal	3195 m.	Globigerina ooze and pumice.

Paragonaster stenostichus Fisher.

Paragonaster stenostichus, Fisher, 1913, p. 627 ; 1919, p. 232, pl. 60, fig. 2, pl. 70, fig. 2, pl. 71, fig. 1, pl. 91, figs. 10, 10*a* ; Döderlein, 1924, p. 50.

Occurrence :

St. 105, Zanzibar area, 238–293 m., green mud ; 1 specimen.

St. 110, ,, ,, 347–384 m., grey-green mud and sand ; 1 specimen.

Distribution.—Philippine Islands, Banda Sea ; Zanzibar.

Description.—

	R, mm.	r, mm.	R/r.	Number of SMPs.	Breadth of arm at level of successive SMPs., mm.				Breadth of paxillar area at level of successive SMPs., mm.			
					4th.	8th.	15th.	30th.	4th.	8th.	15th.	30th.
(1).	92	25	3·6	38	19	14	10	4·5	12	5	1	0·5
(2)	80	22	3·6	36	18	13	9	4·5	10	3·5	1	0·5

The breadth of the arm and of the paxillar area in this table is measured across the distal edge of the supero-marginal plates.

The *abactinal paxillæ* are hexagonal, with nineteen to twenty-one polygonal central granules and twenty to twenty-five smaller truncate peripheral granules. Beyond the level of the eighth supero-marginal plate the carinals become rectangular, the length being greater than the breadth. They extend to the tip of the ray, while the first lateral row of plates reaches about the fifteenth, and the second lateral row of plates about the tenth supero-marginal.

The *supero-marginal plates* are broader than long. The breadth decreases uniformly from the first plate, while the length increases up to the eighth plate and thence decreases, remaining, however, less than the breadth to the tip of the ray. The surface of each plate is covered with coarse polygonal granules, which are larger in the centre. The *infero-marginals* correspond with the supero-marginals. They are covered with squamiform granules from among which spring four to six fine spinelets.

The measurements of the marginal plates are as follows :

	Plate No.									
	Supero-marginals.				Infero-marginals.					
	1.	8.	15.	25.	1.	4.	8.	16.	30.	
Larger specimen, length .	2	2·75	2	1·75	1·75	2	2·5	2·25	1·25	mm.
,, ,, breadth .	6·5	5·5	5	2	8	7·5	5	3·5	1·25	,,
Smaller specimen, length .	2	2·5	2·5	1·5	1·75	2	2	2	1·25	,,
,, ,, breadth .	6	5	4	2·5	6	5·5	4	2·5	1·25	,,

The *actinal intermediate plates* bear three rows of four to six papilliform granules and usually a fine spinelet in the centre.

The furrow margin of the *adambulacral plates* is angular, with the apex nearer the proximal end of the first six or seven plates, but coming to lie in the centre of the rest. There are six to eight furrow spines, and on the actinal surface of the plate about twenty papilliform granules from among which spring fine acicular spines, two in number on the first ten plates, a single one on the rest.

Remarks.—The specimens differ from Fisher's description of the type in the following respects : (i) the eighth supero-marginal is the largest, in the type the fifth ; (ii) the infero-marginal spinelets number four to six, while in the type there are only two or three ; (iii) fine spines occur on the actinal intermediate plates, and a second fine spine is found on the proximal adambulacral plates. These are absent from the type (R 45 mm.), and also from the slightly larger specimen (R 53 mm.) described by Döderlein.

Both specimens are considerably larger than previously described examples and the three characters in which they differ may well be due to growth changes. In the remaining features they agree closely with the description of the type.

Paragonaster ctenipes breviradiatus subsp. n. (Pl. II, fig. 6.)

Occurrence :

St. 105, Zanzibar area, 238–293 m., green mud ; 17 specimens.
St. 106, ,, ,, 183–194 m., ,, ,, 46 ,,
St. 153, Maldives, 256–293 m., 1 specimen.

Diagnosis.—Close to *Paragonaster ctenipes* Sladen, but differing in having shorter,

more tapering arms with fewer marginal plates; more granules on the abactinal and supero-marginal plates: two rows of fine tapering spinelets on the first few infero-marginals, fine tapering spinelets on the actinal intermediate plates and a pair of fine tapering spinelets on the proximal adambulacral plates.

Description.—There is very little variation in this collection, and the description is taken from the thirty-one specimens whose major radius measures between 35 and 53 mm.

The top of the first four to seven *carinal plates* is regularly hexagonal, and bears ten to fourteen polygonal central granules enclosed by a ring of nineteen to twenty-four smaller angular granules. The carinal row extends to the tip of the ray, and at the level of the fourth supero-marginal the shape of the plates changes abruptly from polygonal to rectangular. The first rectangular plate is broader than long, and distinctly broader than the plate preceding it; the remainder are square or a little longer than broad. All bear granules similar to those on the supero-marginal plates.

The plates of the *first lateral row* are identical in size and granulation with the carinals, but there are only six to eight of them, ceasing at the level of the fourth supero-marginal plate. The plates of the second lateral row are similar but slightly smaller and reach the third supero-marginal plate. This row bounds an interradial area where the plates, some thirty in all, are rather irregular in size and shape and closely crowded together. Each is armed with six to twelve peripheral and one to six central granules.

The first *supero-marginal plate* is about two-and-a-half times as broad as long. Both dimensions increase up to the fourth or fifth plate, and thence decrease, the breadth rather more rapidly than the length, as is shown in the following table:

	Plate No.				
	1.	4.	8.	16.	24.
Length . . .	1·5	2	1·75	1·25	1 mm.
Breadth . . .	3·5	4·5	3	2·25	0·75 mm.

The surface of the first few plates is closely covered with flat, polygonal, rather large granules arranged in irregular rows; beyond the fifth plate the granules become relatively smaller and the distance between them is greater, amounting to a little more than their radius. There are approximately eight rows of granules on the first plate, ten on the fifth, and ten to twelve on the eighth.

The *infero-marginal plates* correspond to the supero-marginals. The breadth of the first plate is three times the length; the length increases up to the third or fourth plate and thence decreases slowly, while the breadth decreases rather fast. The plates are covered with squamiform granules, among which, on the first few plates, can be made out two rows of three fine spinelets. These spinelets become fewer and very hard to detect on the plates of the arm, but a single one can be made out on six beyond the fifteenth.

The *actinal intermediate plates* are arranged in three chevrons, the innermost containing seven plates reaching the third infero-marginal. Each plate is beset with three rows of four or five papilliform granules, and nearly every one of those in the first two chevrons bears in addition a fine tapering pointed spinelet.

The *adambulacral plates* bear six or seven flattened furrow spines set on an angular margin. The spine at the apex stands with its edge towards the furrow, while two spines on the proximal facet and three or four spines on the distal facet present their flat surfaces

towards the furrow. Three or four elongate granules on the distal and proximal edges of each plate decrease in size as they recede from the furrow and give the impression of being a continuation of the furrow series. Three or four granules and two fine, long, tapering spinelets occupy the centre of the actinal surface of the proximal plates. There is only one spinelet on those plates which lie beyond the limit of the actinal intermediate areas.

Colour.—Paxillar area, brownish red; supero-marginal plates, light coral red; actinal surface, white.

Growth Changes.—The largest member of the collection has R 53 mm., the smallest R 10 mm. Between these extremes the specimens may be conveniently placed in three groups illustrating the changes which accompany growth.

Group.	Number of specimens.	R, mm.	r, mm.	R/r.	Number of SMPs.	Occurrence of spinelets on IMPs., Act. int. plates, Adamb. plates.
I	8	10–12	3·3–4	3	8–11	None.
II	25	18–34	6–10	3–3·6	14–24	Variable. Ranging from complete absence to presence on almost every plate.
III	31	35–53	11–16	3·2–3·8	24–30	Variable in number, but some always present.

Affinities.—The largest specimen is about the same size as Sladen's type of *Paragonaster ctenipes* which is lodged in the British Museum. I have compared the two side by side and find the following differences: (i) the subspecies *breviradiatus* has the arms shorter and more tapering and there are fewer marginal plates; (ii) the central granules of the abactinal plates and all the granules of the supero-marginal plates are more angular, larger, more numerous, and in consequence more closely crowded in *breviradiatus*; (iii) the distribution of fine spinelets on the actinal surface is more abundant than in Sladen's type; there are two rows instead of one on the first few infero-marginals, there is one on many actinal intermediate plates—a condition not found in the type—and there are two on the proximal adambulacral plates, where in the type there is never more than one; (iv) in the type the spines on the adjacent edges of the adambulacral plates are long, and arch over the suture between the plates in such a manner as to suggest a fasciolar pedicellaria. In *breviradiatus* the arrangement is essentially the same, but the spines are shorter and the whole structure is, therefore, much less conspicuous.

An interesting form from the Eastern Archipelago is almost the exact counterpart of *P. ctenipes breviradiatus*, as far as granulation and spinulation is concerned, but differs in having the arms longer than those of *P. ctenipes*. Fisher regards this form as a subspecies and gives it the name *Paragonaster ctenipes hypacanthus*. I have followed his example and created a corresponding subspecies for the present collection of specimens.

Sub-family Goniasterinae.

Genus *Rosaster* Perrier.

In his key to the *Goniasteridæ*, Fisher (1911, p. 158) recognizes both *Nereidaster* and *Rosaster* as separate genera. They are united, and the generic diagnosis revised, in his work on the Philippine Asteroids (1919). Besides the species assigned to the genus in this latter paper, the distribution table below includes *Nymphaster florifer* Alcock, which

Fisher (1911) has tentatively assigned to the genus *Mediaster*, but which I find to be only slightly different from *Rosaster cassidatus* n. sp. described below.

Ocean.	Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*alexandri* (Perrier)	Perrier, 1884, 1894	8	5	Gulf of Mexico	153–3473 m.	..
		Verrill, 1915	Many		West Indies	151–3473 m.	..
Eastern Archipelago	*nannus* Fisher	Fisher, 1913	7	3	Philippines	61–98 m.	Soft green mud, coral sand.
		Döderlein, 1924	31	1	Molo Strait	54–90 m.	..
	mammillatus Fisher	Fisher, 1913	1	1	Philippines	110 m.	Sand, shell, gravel.
	mimicus Fisher	,, ,,	4	3	,,	266–452 m.	Dark grey sand.
	symbolicus (Sladen)	Sladen, 1889	..	2	,, Torres Strait	50–209 m	Green mud. ..
		Fisher, 1919	2	2	Philippines	185–328 m.	Sand.
	bipunctus (Sladen)	Sladen, 1889	..	1	New Guinea	273 m.	Grey mud.
Indian	*confinis* (Koehler)	Koehler, 1910	1	1	Andaman Sea	121 m.	..
	confinis subsp. *timorensis* Döderlein	Döderlein, 1924	1	1	Timor Sea	216 m.	Coral sand.
	florifer (Alcock)	Alcock, 1893	..	..	Andaman Sea	236–456 m.	..

Rosaster cassidatus sp. n. (Pl. III, figs. 3 and 6 ; Text-fig. 4.)

Occurrence :

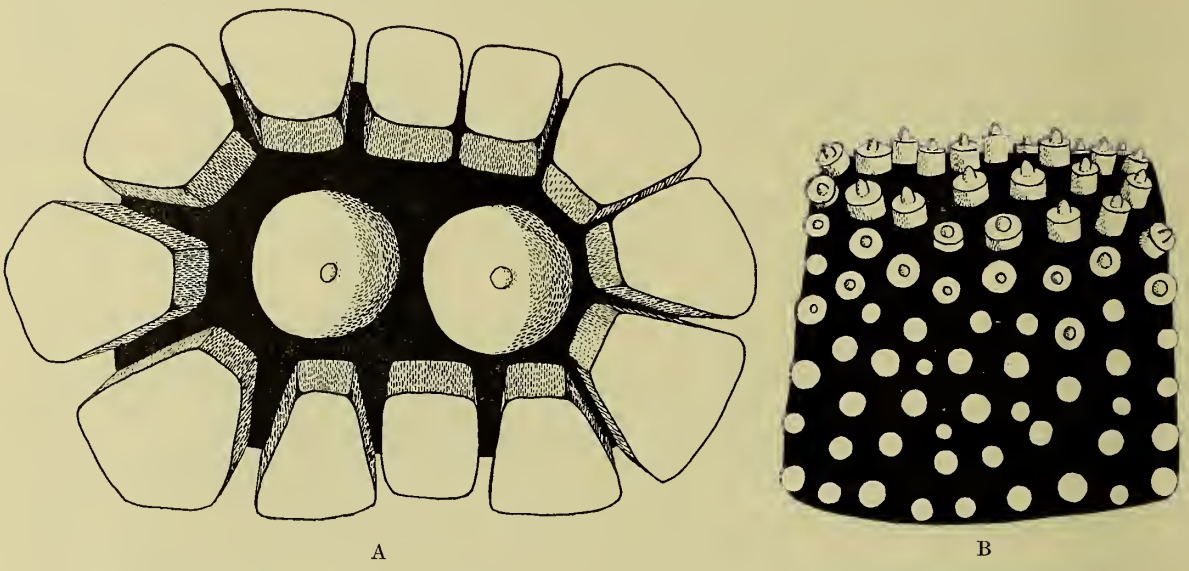
St. 153, Maldives, 256–293 m. ; 57 specimens.

St. 157, ,, 229 m., coral rock ; 1 specimen.

Diagnosis.—R/r 2·9 to 3·1. Disk thin and flat ; arms fine, tapering, rectangular in cross-section ; interbrachial arcs widely rounded. Abactinal plates connected internally by radiating ossicles ; arranged externally in conspicuous radial " petals " each with seven rows of plates, and small triangular interradial areas ; plates of radial areas with eight to twelve angular peripheral and one to three spherical central granules ; plates of interradial areas with six to eight small pointed granules surrounding a single central ; a minute projection on top of most of the granules of interradial plates and on top of central granules of radial plates. Supero-marginal plates twenty to twenty-five ; on proximal half of arm plates separated by a row of carinals, towards tip of arm a few plates usually in contact ; surface beset with cylindrical granules, increasing in size and becoming surmounted by minute projection towards outer edge of abactinal face, becoming pointed towards actinal edge of lateral face. Infero-marginals similar to supero-marginals, but granulation of actinal face coarser. Actinal intermediate plates in four rather irregular chevrons, the innermost reaching the fourth infero-marginal ; plates armed with three or four rows of three or four pointed granules. Adambulacral plates longer than broad, bearing a furrow series of four to eight (usually

five or six) fine radiating flattened spines; on the actinal surface one or two rows of pointed granules, those of the inner row often elongated.

Description.—R 30 to 40 mm. The petaloid radial areas of the *abactinal surface* were very striking in the living specimens, which were beautifully coloured, and they are conspicuous in the preserved material owing to the occurrence of six pores about the base of each component plate. The plates are arranged in seven rows, and all, except those in the carinal row, which are a little broader than long, are regular hexagons. Each has a peripheral series of eight to twelve angular granules and, except for the carinals, which may have two or even three, a single central granule. The central granules consist



A B

Text-fig. 4.—*Rosaster cassidatus* sp. n. A, Carinal plate × 125. B, Supero-marginal plate, abactinal surface × 50.

of a very short stalk and a spherical head, on top of which is a minute projection seen clearly only in dried specimens (Text-fig. 4A).

The *carinal plates* may reach the terminal plate in an uninterrupted series, or, becoming smaller and smaller, may disappear, leaving as many as seven supero-marginals in contact abactinally. More often at the level of about the sixteenth supero-marginal the carinals cease to touch each other and continue as oval plates, each one completely enclosed by four supero-marginals. There may be but two or three of these isolated carinals, or they may persist as far as the last pair of supero-marginal plates. At the level of the sixth supero-marginal the carinal plates are square, with the granules arranged in three rows of three, and on the distal half of the ray the plates are longer than broad. Twelve plates extend to the level of the fourth supero-marginal, and beyond this point two carinals correspond approximately to one supero-marginal.

The first lateral row of plates usually ceases at the level of the sixth supero-marginal, but occasionally isolated plates may be detected for some distance farther down the ray.

In the interradial areas the plates are small and square. They lie in five rows parallel with the radial plates and successive rows contain approximately 9, 7, 4, 3 and 2 plates. Each is beset with six to eight angular peripheral granules, lying about a single one in the centre. A minute projection occurs on top of nearly every one of these granules.

The *supero-marginal plates* form a broad border to the paxillar area, and together with the infero-marginals, a straight vertical or slightly concave side to the disk and arms. The dimensions of plates from a specimen with R 39 mm. are :

	Plate No. 1.	4.	8.	16.
Height	1·25	1·25	0·75	0·5 mm.
Length	1·75	2	1·75	1 mm.
Breadth	1·75	1·75	1·25	1 ,,

There are six to eight rows of granules on the surface of the plates, very regularly arranged in some specimens, irregular in others. The granules take the form of small cylinders with the height and diameter approximately equal. Near the inner border of the plate they are of about the same size as the granules on the neighbouring abactinal interradial plates, but towards the outer border of the plate they become larger and are surmounted by a minute projection (Text-fig. 4B). These armed granules extend about half-way down the lateral face of the plate and then give way to very sharp fine spinelets, perhaps 0·25 mm. in length. Two-valved pedicellariæ occur on some of the supero-marginal plates : they do not, as far as can be made out, occur anywhere else.

The *infero-marginal plates* correspond to the supero-marginals only in the interradius and at the tip of the ray. Their granulation is similar, fine spinelets occur on the lateral face and armed cylindrical granules occur in the neighbourhood of the free border, but on the actinal surface the granules become coarse and pointed.

The *actinal intermediate plates* are irregularly square and well separated from each other. It is possible to make out four chevrons, containing 8 to 10, 5 to 7, 2 to 4, and 1 to 3 plates, as well as one or two odd plates alongside the interradial line. The plates are armed with coarse pointed fluted granules in three or four rows, each row containing three or four granules.

The *adambulacral plates* bear a furrow series of very flattened radiating spines, of which the most proximal is smaller than the rest, which are subequal. The spines present their edges to the furrow, and viewed from the furrow they appear straight-sided and truncate. If the flat surface be examined it is seen that the spines are slightly curved and sometimes a little swollen at the tip. Usually there are five spines on the first few plates ; the number increases to six and not infrequently seven in the neighbourhood of the fifth or sixth plate. Occasionally there are only four spines on the proximal plates ; in one specimen there are eight spines on the distal plates. On the actinal surface of the plate there are commonly two rows of four granules similar to those of the actinal plates. One or two of the granules in the inner row are often elongated, and attain a length equal to a quarter or a third of that of the furrow spines. Many plates, however, bear but a single row, in which case none of the granules are elongated.

The *mouth plates* bear eight or nine furrow spines and, parallel with them on the actinal surface, a row of three to five pointed spines square or triangular in cross-section. Four to six pointed granules stand near the distal border of the plate.

Colour.—" Petals," russet vinaceous ; carinals along the arms, coral red ; abactinal interradial areas, light coral red ; supero-marginals, salmon buff ; actinal surface, white.

Variation.—One specimen with four arms was taken.

Young Forms.—The characters set forth above are those of fifty-two specimens with a major radius of between 30 and 40 mm. Six smaller specimens were caught and the characters in which they differ from the larger are tabulated below.

R, mm.	r, mm.	R/r.	Number of SMPs.	Number of plates in Act. int. chevrons.	Number of furrow spines.	Condition of carinals.
16	6	2·6	11	5, 3, 1	4 to 5	Reaching TP. in continuous series along three arms, in discontinuous series from 8th SMP. along two.
16	6	2·6	11	6, 3, 1	5 to 6	Not reaching TP. In discontinuous series from 4th SMP.
10	4	2·5	11	3, 2	4	Reaching TP. in discontinuous series from 3rd SMP.
13	5	2·6	12	4, 3	4 to 5	
15	5	3	11	4, 3	4 to 5	
13	5	2·6	9	4, 3	4 to 5	Reaching TP. in continuous series.

Affinities.—This species may be distinguished at once from *R. alexandri* (Perrier), *R. nannus* Fisher, *R. confinis* (Koehler), *R. mimicus* Fisher and *R. bipunctus* (Sladen) by the line of carinal plates between the supero-marginals. It differs from *R. mammillatus* Fisher in lacking any tubercular structure on the supero-marginal plates. *R. symbolicus* (Sladen) has more numerous abactinal granules (twenty-two to twenty-five peripheral and seven to eight central) and more furrow spines (ten). *R. cassidatus* is very close to the starfish named *Nymphaster florifer* by Alcock, a species which Fisher suggests may belong to the genus *Mediaster*.

From Alcock's description two differences emerge: (i) the supero-marginals of *florifer* never meet, and (ii) the furrow spines number seven to eight. In the present series of specimens it is exceptional for no supero-marginals to meet, though this condition is occasionally found, and only one specimen out of fifty-eight has as many as eight furrow spines, the usual number being five or six. Through the kindness of the Indian Museum I have been able to examine two small specimens of *N. florifer* from their collection. They have the following characters:

R, mm.	r, mm.	R/r.	Number of SMPs.	Number of plates in Act. int. chevrons.	Number of furrow spines.	Condition of carinals.
22	7	3	15	7, 4, 2	6 to 7	Reaching TP. in continuous series.
22	8	3	16	7, 4, 2	6 to 7	Ditto.

These figures bear out the difference noted in the description, and a third point of difference is apparent on comparison. The supero-marginal plates are distinctly narrower in the Indian Museum specimens and are longer than broad almost to the tip of the ray.

The differences between the two species are thus slight, but, while doubt exists as to the true generic position of *florifer*, I have deemed it the safer course to create a new species for the present series of examples. Their position in the genus *Rosaster* has been confirmed by an examination of the internal plates.

Genus *Mediaster* Stimpson.

The first adequate account of the genus is given by Verrill (1899, p. 178), and a further revision has been made by Fisher (1911, p. 196). The list of species in the following distribution table is taken from the latter paper, and includes the three species (*M. pedicellaris*, *M. agassizii* and *M. florifer*) whose position in the genus has still to be confirmed, though it is believed that *M. florifer* will ultimately find a resting-place in the genus *Rosaster* (*see* p. 368). The table also includes *M. sladeni* Benham (1909), a species not referred to by Fisher, and three species described since 1911.

Ocean.	Species. (Synonyms in brackets.)	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*pedicellaris* (Perrier)	Perrier, 1884	5	3	West Indies	200–320 m.	Fine black sand; hard ground.
		Verrill, 1915	1	1	,, ,,	217–324 m.	..
	bairdii (Verrill)	,, 1899	..	5	Coast of U.S.A.	860–1313 m.	..
	(*stellatus* Perrier)	Perrier, 1896	..	1	Newfoundland	1267 m.	Sand and stones.
		Grieg, 1932	5	1	,,	1100 m.	..
	agassizii Verrill	Verrill, 1899	..	..	West Indies	..	..
Pacific	*æqualis* Stimpson	Stimpson, 1857	..	..	California	50 m.	..
		Fisher, 1911	231	60	Alaska to California	16–300 m.	Various.
		Bush, 1918	" Rather numerous "		Puget Sound	..	..
		Ulrey, 1918	..	32	S. California	36–288 m.	Various.
	tenellus Fisher	Fisher, 1904	..	..	,,	816–932 m.	..
	transfuga Ludwig	Ludwig, 1905	8	1	Gulf of Panama	902 m.	Green mud.
	brachiatus Goto	Goto, 1914	..	2	Japan	493–1000 m.	..
Indo-Pacific	*præstans* Livingstone	Livingstone, 1933	..	..	Great Barrier Reef	..	..
	sladeni Benham	Benham, 1909	..	11	New Zealand	45–55 m.	Shell, gravel.
	arcuatus (Sladen)	Sladen, 1889	1	1	Japan	630 m.	Green mud.
		Goto, 1914	3	..	,,	877–1023 m.	,, ,,
		Alcock, 1893	1	1	Andaman Sea	500 m.	,, ,,
	ornatus Fisher	Fisher, 1906	35	9	Hawaii	520–1155 m.	Sand, various.
		,, 1919	3	2	Philippines	745–877 m.	Green mud and coral.
		Döderlein, 1924	1	1	New Guinea	1633 m.	Coral.
		Koehler, 1909	3	1	Gulf of Oman	898 m.	
	florifer (Alcock)	Alcock, 1893	..	..	Andaman Sea	236–456 m.	..
	capensis H. L. Clark	Clark, 1923	4	2	Cape of Good Hope	36–158 m.	Green mud and sand.
		Mortensen, 1933	2	1	,, ,,	168 m.	..
	capensis var. *durbanensis* Mortensen	,, ,,	1	1	,, ,,	405 m.	..

Mediaster ornatus Fisher.

Mediaster ornatus, Fisher, 1906, p. 1046, pl. xvi, figs. 3, 3*a*, pl. xx, figs. 1 and 2 ; Koehler, 1909, p. 78 pl. x, fig. 4 ; Fisher, 1919, p. 256 ; Döderlein, 1924, p. 52, pl. xiv, figs. 6 and 6*a*.

Occurrence :

St. 159, Maldives, 914–1463 m. ; 1 specimen.

Distribution.—Hawaii, Gulf of Oman, Philippines, New Guinea ; Maldives.

Remarks.—The species has been thoroughly described and figured and I have no hesitation in referring to it a specimen with the following characters : R 40 mm., r 16 mm., R/r 2·5 ; supero-marginals twenty-two ; breadth of ray at level of fourth supero-marginal, 10 mm., eighth supero-marginal, 6 mm., twelfth supero-marginal, 4 mm., and sixteenth supero-marginal, 2·5 mm. The abactinal plates are arranged in regular radial series. The carinals are the largest and have about eighteen peripheral and twelve central granules, the latter in three rows. The actinal intermediate plates lie in regular chevrons, of which the innermost reaches the ninth infero-marginal. In successive chevrons there are some 20, 16, 11, 8, 6, 5 and 3 plates. The adambulacral plates have six to eight furrow spines, and actinally an outer row of five granules and an inner row of five spines, more robust and shorter than the furrow spines.

The number of furrow spines is evidently liable to some variation, for the type has eight, Koehler's examples five, Fisher's Philippine examples five to seven, and Döderlein's examples eight to eleven. The present specimen resembles the type in this character, while agreeing with Döderlein's material in the rather large number of granules on the abactinal plates.

Mediaster murrayi sp. n. (Pl. III, figs. 1, 2 and 4 ; Text-fig. 5.)

Occurrence :

St. 107, Zanzibar area, 421–457 m. ; 5 specimens.
St. 109, ,, ,, 640 m., light grey mud ; 43 specimens.
St. 123, ,, ,, 256–366 m., green mud, sand, rock ; 9 specimens.

Diagnosis.—R/r 2·4 to 2·8. Abactinal surface inflated ; actinal surface flat ; arms tapering somewhat broadly at base, more sharply from a point about midway down, tip rounded ; interbrachial arcs rather flattened. Abactinal plates in regular radial series ; hexagonal, the carinals broader than long, with twenty to thirty truncate peripheral granules and six to twelve hemispherical central granules in one, two or three regular rows. Supero-marginals confined to side wall of disk but encroaching gradually on to abactinal surface of arms ; with regular rows of granules and one or two pedicellariæ. Infero-marginals alternating with supero-marginals except interradially, granulation coarser. Actinal intermediate areas small for the genus ; plates arranged in about six chevrons, the innermost reaching the fifth or sixth infero-marginal. Adambulacral plates with seven to nine delicate radiating flattened furrow spines, and actinally two series, an inner of three coarse spines and two granules, and an outer of four or five granules.

Description.—R 30 to 47 mm., r 11 to 17 mm. The table below, giving the breadth of the arm at the level of successive marginal plates, is from a specimen with R 40 mm. The rest of the description is based on all the specimens.

	Plate No.			
	4.	8.	12.	16.
Breadth of arm . .	10 .	6 .	5 .	3·5 mm.

The radial areas of the *abactinal surface* comprise nine regular rows of hexagonal plates. The carinals are two to three times as broad as long, while of the plates in the four rows on either side, the first differ only in being scarcely longer than broad and the rest show a progressive diminution of size as the interradial areas are approached. Each plate in the radial area has six papulæ around it, one opposite each corner. The interradial areas are paved with four-sided, closely crowded plates.

The carinal plates have round the edge twenty to thirty radiating subtruncate granules, and in the centre six to twelve granules which are well spaced and arranged in regular rows, of which there is occasionally only one, usually two, and less frequently three. The interradial plates have eight to ten peripheral granules round a single one in the centre. Most of the plates of the radial areas, and many of those in the interradial areas as well, bear a two-valved pedicellaria of rather simple form (Text-fig. 5A).

The carinals usually reach the terminal plate. The first lateral row persists for a distance which is very variable and may be different on the two sides of one arm. They usually disappear in the neighbourhood of the seventeenth supero-marginal but in some specimens they appear to cease abruptly at the level of the twelfth. In this case the carinals which, from the level of the sixth supero-marginal, show a gradual transition from a hexagonal to a square shape, suddenly become rectangular, with the breadth quite three times the length. This effect is almost certainly due to fusion of the carinal and first lateral plates.

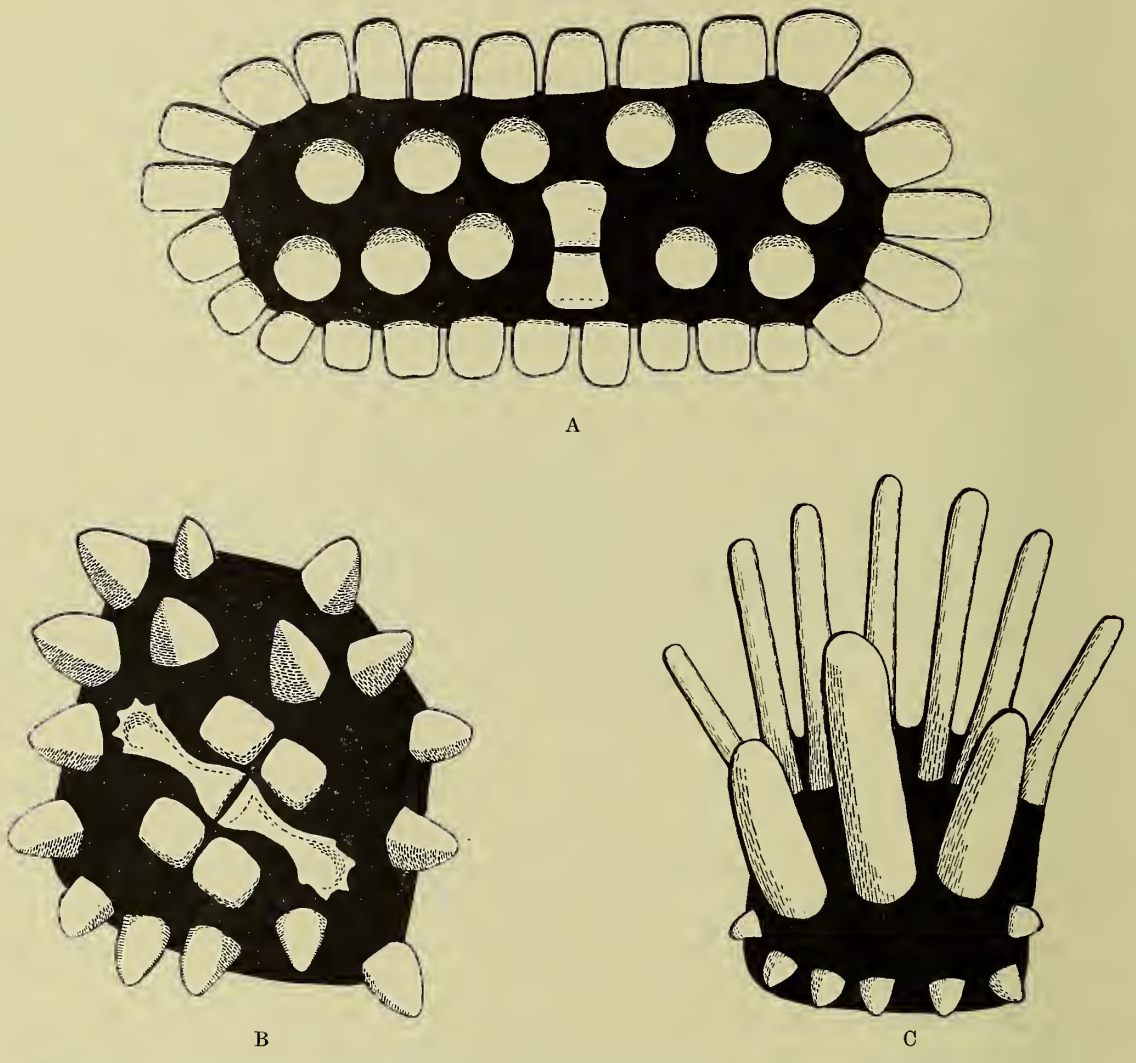
The *supero-marginal plates* number twenty-one to twenty-four. They are confined to the side of the disk and base of the ray, but at about the seventh, or in some of the larger specimens not till the twelfth plate, they begin to encroach on to the abactinal surface, and this continues to the tip of the ray, where the last pair may be in contact. The first plates are higher than long but the length increases somewhat abruptly, and from the third or fourth plate outwards they are square. Both dimensions decrease equally till the last eight or ten plates, where the height is again greater than the length. The plates are beset with small well-spaced hemispherical granules in regular rows, of which there are six on the first plate and eight or nine on the fifth. Each plate bears one, occasionally two pedicellariæ.

The *infero-marginal plates* usually alternate with the supero-marginals, except interradially. Their granules are coarser and more pointed than those of the supero-marginals. The plates encroach on to the actinal surface of the disk but are confined to the side walls of the rays.

The *actinal intermediate areas* are paved with numerous quadrangular plates arranged in about six chevrons, of which the innermost reaches the fifth or sixth infero-marginal. A typical arrangement is 13, 9, 7, 4, 2, 1 plates in successive chevrons. The plates are well spaced from one another, and each is surmounted by three or four rows of three or

four pointed or rounded granules (Text-fig. 5B). Most of the plates of the inner chevron and a certain number of the remainder bear pedicellariæ.

The pedicellariæ of the marginal and actinal plates consist of two long spatulate jaws sunk in a slight depression. These jaws may lie isolated, but usually two or four granules are situated on the edge of the pit and slightly overlie it. There is no indication that these granules are mobile, but the whole complex suggests a multivalvular pedicellaria.



TEXT-FIG. 5.—*Mediaster murrayi* sp. n. A, Carinal plate × 125; B, Actinal intermediate plate × 125; C, Adambulacral plate × 125.

The *adambulacral plates* (Text-fig. 5C) bear on a uniformly rounded furrow margin seven to nine delicate flattened round-tipped radiating spines. On the actinal surface there is an outer series of four or five granules and an inner series, which is usually made up of two granules at the edges and three spines in the centre. The middle spine is flattened, rather pointed, twice as thick and nearly as long as the furrow spines. The other two may be as long as this middle spine or considerably shorter.

The *mouth plates* have twelve furrow spines. On the actinal surface there are two

series, one consisting of three granules distally and three coarse spines proximally, parallel with the furrow, the other consisting of five or six granules, parallel with the suture between the two plates.

Internal radiating ossicles connecting the abactinal plates and very small super-ambulacral ossicles are present.

Colour.—The colour was the same all over the body, and in the forty-three specimens from St. 109 it varied from coral pink to light coral red or coral red.

Variation.—A single specimen from St. 109 has six arms, but in the remainder of its features agrees with the rest of the collection.

For the most part there is little variation, and an account of such as does exist is incorporated in the description. There is, however, one extremely interesting feature, namely, the tendency for the abactinal plates to fuse. In about ten specimens the carinals fuse with the first lateral plates at the level of the twelfth supero-marginal plate. In two specimens from St. 109 the fusion begins at the base of the ray, level with the fifth supero-marginal. There are never more than two plates fused together, but while a carinal plate only fuses with a first lateral, the plates in this row may fuse with each other, as well as with the plates on either side. The most extreme condition is found in a specimen from St. 123. Here the carinals fuse at the base of the ray with the laterals on both sides, and great boomerang-shaped plates, which distally become rectangular, are formed.

This tendency to fuse may lead to a great irregularity in the plates of the ray, and had a specimen with this feature turned up alone it might well have been made the type of a new genus.

Affinities.—The species is distinct and, judging from descriptions, not closely related to any other. Its salient characters are the broad carinals, supero-marginals confined to side wall of disk, relatively small actinal intermediate areas and relatively numerous long furrow spines.

Genus *Nymphaster* Sladen.

Fisher (1919, p. 263) discusses the synonymy of this genus.

Thirty species have been ascribed by various authors to this genus, but of these six have been referred to other genera, namely :

Species.	Author.	New genus.	Author of change.
Nymphaster symbolicus	Sladen, 1889	*Nereidaster*	Verrill, 1899.
N. bipunctus	Sladen, 1889	*Rosaster*	Fisher, 1913.
Dorigona longimana	Möbius, 1859	*Iconaster*	Bell, 1884.
D. pentaphylla	Alcock, 1893	*Iconaster*	Koehler, 1909.
D. pentaphylla	Alcock, 1893	*Lithosoma*	Fisher, 1919.
D. confinis	Koehler, 1910	*Rosaster*	,, 1913.
Nymphaster florifer	Alcock, 1893	*Mediaster*	,, 1911.

The distribution of the remaining species is shown in the accompanying table. Many of the species are now regarded as synonyms. Those in the Atlantic are discussed by Verrill (1899) and Farran (1913), and those in the Indian Ocean are discussed below.

Ocean.	Species. (Synonyms in brackets.)	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*arenata* (Perrier)	Perrier, 1884	9	8	Gulf of Mexico	298–1605 m.	Fine sand and mud.
		,, 1894	54	15	Coast of Morocco	530–1635 m.	Mud.
		Koehler, 1895	1	1	Coast of France	560–1400 m.	..
		,, 1909*a*	"Very frequent"		N. Atlantic	820–1440 m.	Hard ground; sandy mud; fine sand.
		Farran, 1913	126	12	W. coast of Ireland	379–1659 m.	Various.
		Grieg, 1932	3	1	Coast of Spain	535 m.	Yellow sand.
	(*protentus* Sladen)	Sladen, 1889	1	1	SW of Canary Is.	2787 m.	Hard ground.
		Bell, 1889	..	5	SW of Ireland	..	..
	(*subspinosus* Perrier)	Perrier, 1884	6	2	Gulf of Mexico	761–1342 m.	..
		Koehler, 1895	1	1	Coast of France	400–500 m.	..
	(*prehensilis* Perrier)	Perrier, 1884	..	..	Coast of Morocco	..	..
	(*jacqueti* Perrier)	,, 1894	36	8	Coast of Spain	550–1238 m.	..
		Koehler, 1895	5	2	Coast of France	960 m.	..
	ternalis (Perrier)	Perrier, 1884	2	2	Gulf of Mexico	761–1342 m.	..
	albidus Sladen	Sladen, 1889	1	1	Off Cape Verde	..	..
	basilicus Sladen	,, ,,	1	1	Coast of Brazil	2193 m.	Red mud.
Pacific	*diomedeæ* Ludwig	Ludwig, 1905	53	4	Galapagos and Cocos Is.	702–1812 m.	Globigerina ooze and sand.
	pentagonus H. L. Clark	Clark, 1916	1	1	Great Australian Bight	450–800 m.	..
Eastern Archipelago	*euryplax* Fisher	Fisher, 1913, 1919	1	1	Mindanao Sea	319 m.	Globigerina ooze.
	dyscritus Fisher	,, ,, ,,	2	2	Philippine Is.	394–402 m.	Green mud; fine sand and broken shells.
	mucronatus Fisher	,, ,, ,,	1	1	Balayan Bay	365 m.	..
	moluccanus Fisher	,, ,, ,,	2	2	Molucca Is.	400 m.	Grey mud; grey mud and fine sand.
	arthrocnemis Fisher	,, ,, ,,	3	2	Celebes Is.	1050–1260 m.	Green mud.
	meseres Fisher	,, ,, ,,	2	2	Philippine Is.	700 m.	Fine sand.
	habrotatus Fisher	,, ,, ,,	5	3	,, ,,	612–1324 m.	Green mud, coral.
	atopus Fisher	,, ,, ,,	3	1	Sulu Sea	2000 m.	Grey mud.
	leptodomus Fisher	,, ,, ,,	11	2	Luzon	396 m.	Green mud.
Eastern Archipelago to Indian	*mœbii* (Studer)	Studer, 1884	..	..	NW coast of Australia	350 m.	..
		Döderlein, 1924	..	..	Eastern Archipelago	450–462 m.	Globigerina ooze; grey mud.
	(*ternalis* Koehler)	Koehler, 1909	4	4	Bay of Bengal, W. of Ceylon Arabian Sea	1097–2504 m.	..
	(*belli* Koehler)	,, ,,	1	1	Andaman Is.	456 m.	..
	(*ludwigi* Koehler)	,, ,,	..	..	Laccadive Sea	2504 m.	Coral mud.
	nora Alcock	Alcock, 1893	..	..	Andaman Sea	882 m.	..

Nymphaster mœbii (Studer). (Pl. IV, figs. 1 to 10 ; Text-figs. 6, 7 and 8.)

Pentagonaster mœbii, Studer, 1884, p. 30.
Nymphaster protentus, Alcock, 1893, p. 95.
Nymphaster basilicus, Alcock, 1893, p. 95.
Dorigona ternalis, Koehler, 1909, p. 54, pl. viii, figs. 5 and 6.
Dorigona ludwigi, Koehler, 1909, p. 61, pl. ix, figs. 5 and 6.
Dorigona belli, Koehler, 1909, p. 58, pl. viii, figs. 2, 3 and 4.
Nymphaster mœbii, Döderlein, 1924, p. 55, pl. xiv, figs. 2 and 2*a* ; pl. xv, fig. 1.

Occurrence :

St. 105, Zanzibar area, 238–293 m., green mud :	2 specimens.
St. 108, ,, ,, 786 m., grey mud ;	3 ,,
St. 109, ,, ,, 640 m., ,, ,,	1 specimen.
St. 110, ,, ,, 347–384 m., grey green mud and sand ;	3 specimens.
St. 115, ,, ,, 640–685 m. ;	3 ,,
St. 122, ,, ,, 732 m., grey green mud ;	43 ,,
St. 143, Maldives, 797 m., grey sand ;	9 ,,
St. 145, Kardiva Channel, 494 m., green mud and sand ;	2 ,,
St. 184, Gulf of Aden, 1270 m., green mud :	6 ,,

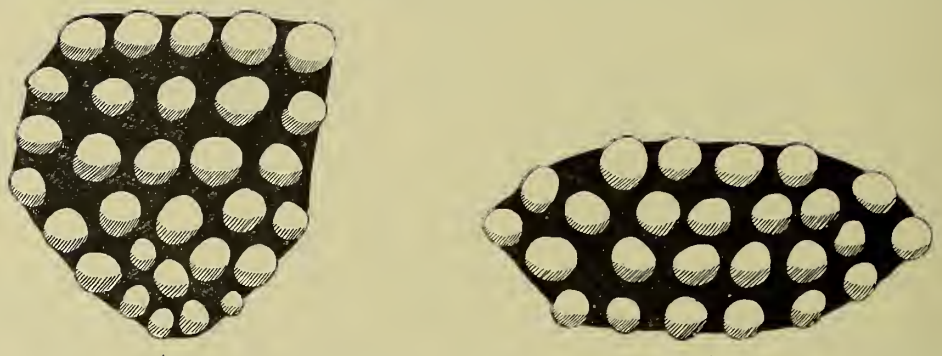
Remarks.—This collection of seventy-two specimens contains forms which, if taken alone, might be referred to six distinct species, viz. *N. mœbii* (Studer), *N. ludwigi* (Koehler), *N. belli* (Koehler) and *N. alcocki* (? nom. nud., *see* p. 380), and perhaps two new species. It is found, however, that between these forms occur others which are intermediate in character, and the specific distinctions of previous authors, based on a small number of specimens, break down. The collection does tend to fall into groups, each group for the most part coming from a different area, but the characters of the groups overlap, and it is believed therefore that the present series of specimens, together with the previously known species in the synonymy list above, belong really to a single variable species. This view is strengthened by a study of the many changes which the names of the previous species have undergone. The first examples collected in the Indian Ocean were identified by Alcock as *N. protentus* Sladen and *N. basilicus* Sladen, both forms known only from the Atlantic. Koehler re-examined the material and decided that Alcock was mistaken. From among the specimens he described two new species, *N. ludwigi* and *N. belli*, and identified others as *N. ternalis* Perrier, another Atlantic form. Döderlein regards Koehler's *ternalis* as identical with the Australian species *N. mœbii* (Studer).

Of the present collection the forty-three specimens taken in the Zanzibar area at St. 122 (Pl. IV, figs. 1, 5, 10, cat. no. 98) resemble most closely the type of *N. mœbii*, and it is therefore on the eleven largest members of this collection (r 18 to 25 mm.) that the diagnosis and description below are based. Twenty-four of the specimens have r 8 to 12 mm. and the characters of these smaller examples are compared with those of the larger. Finally the characters of four lines of variation found in the collection are compared with the diagnosis of the typical form, and reasons why these are not regarded as distinct species are given.

For each specimen variable features such as the number and size of the plates, the number and character of spines or granules on different plates and the number of pedicellariæ on different areas have been recorded in a manuscript, which, since it is too cumbrous to print here, has been deposited with the British Museum (Natural History).

This makes it necessary that each specimen bears a catalogue number, and these numbers are referred to in the following discussion.

Diagnosis.—R/r 3·8–4·4. Disk with abactinal and actinal interradial areas below the level of the marginal plates. Rays long tapering, rectangular or rounded abactinally in cross-section. Abactinal surface with seven columns of plates down each radius; a number of small irregular closely crowded plates in each interradius; carinal plates fourteen to eighteen in number, usually hexagonal, slightly broader than long, sometimes round, square or irregular, the distal two or three often compressed and twice as broad as long, proximal plates with thirty to fifty round granules; three rows of smaller hexagonal



A B

Text-fig. 6.*—*Nymphaster mœbii* (Studer). A, 3rd carinal plate × 50 (No. 100*d*; St. 184); B, 2nd carinal plate × 50 (same specimen).

plates, with similar granulation, on each side of carinal row; pedicellariæ on a variable number of abactinal plates. Supero-marginals in contact down arms; plates bounding disk with sloping abactinal surface, those along arms with abactinal and lateral faces at right-angles or sometimes joining in a widely rounded curve; with about twelve rows of hemispherical granules; a variable number of plates with pedicellariæ. Infero-marginals similar to supero-marginals. Actinal intermediate plates in four chevrons; plates with four or five rows of large round or pointed granules; pedicellariæ on some or many plates. Adambulacral plates with palmate furrow series of compressed spines; first plate with seven spines, number increasing on subsequent plates till all beyond about the tenth bear eleven spines; actinal surface with one to three regular or irregular rows of conical or hemispherical granules, inner row sometimes elongate up to half length of furrow spines; on most plates some of the granules arranged to form a two-, three-, or four-jawed pedicellaria. Mouth plates with ten or eleven furrow spines; on actinal surface nine to fifteen granules, of which two or three nearest the inner angle elongated and as long as furrow spines.

Description.—R 54–112 mm., r 13–25 mm. On the *abactinal surface* the interradial areas are sunk below the level of the supero-marginal plates, and are paved with irregular or square plates closely crowded together. In the radial areas there is a carinal row of fourteen to eighteen plates, with three rows of lateral plates on either side. The larger plates near the proximal end of the carinal row have thirty to fifty granules, and the corresponding plates of the lateral rows sixteen to thirty-four. The granules are hemispherical, and usually about half the number are set round the edge and half are

* The figure is of plates from one of the specimens from the Gulf of Aden. The granules are fewer in number than, but otherwise similar to, those of typical specimens from the Zanzibar area.

irregularly arranged in the centre, but there is no difference in form between the granules of the two groups (Text-fig. 6A). In shape the carinals are usually hexagonal, a little broader than long, but they may be round, square or irregular, and at the outer end of the row two or three are compressed and the breadth is twice the length. The granules on the latter plates number about thirty, and those in the centre are arranged in two regular rows (Text-fig. 6B). In most specimens there are only two or three such carinals, but in others they are more numerous, and in a few examples almost every plate in the carinal row is of this shape. It is noteworthy that Koehler regards this character as diagnostic of *N. belli*. The lateral plates are regularly hexagonal, but towards the edge of the disk they become small and irregular in shape. In some specimens there is a two-jawed pedicellaria on almost every radial and interradial plate, and in others pedicellariæ are absent from the abactinal surface.

There are thirty to forty *supero-marginal plates*. Eight or ten bound the paxillar area of the disk and the remainder are in contact with their opposites down the length of the ray. In transverse section the arm is usually rectangular, sometimes the sides are slightly concave, and in some specimens the lateral and abactinal faces of the supero-marginal plates join at a widely rounded curve instead of a right-angle so that the arm has a D-shaped section. Seen in surface view the plates are usually flat, but sometimes they are a little convex, and sometimes, particularly on the specimens with the rounded arms, they are slightly concave.

The first three or four plates are much broader than high, as the abactinal surface slopes downwards to the outer edge. Along the arms the abactinal surface of the plates is horizontal and the breadth is only a little greater than the height. The following measurements are from a specimen with r 19 mm. (No. 98, 11).

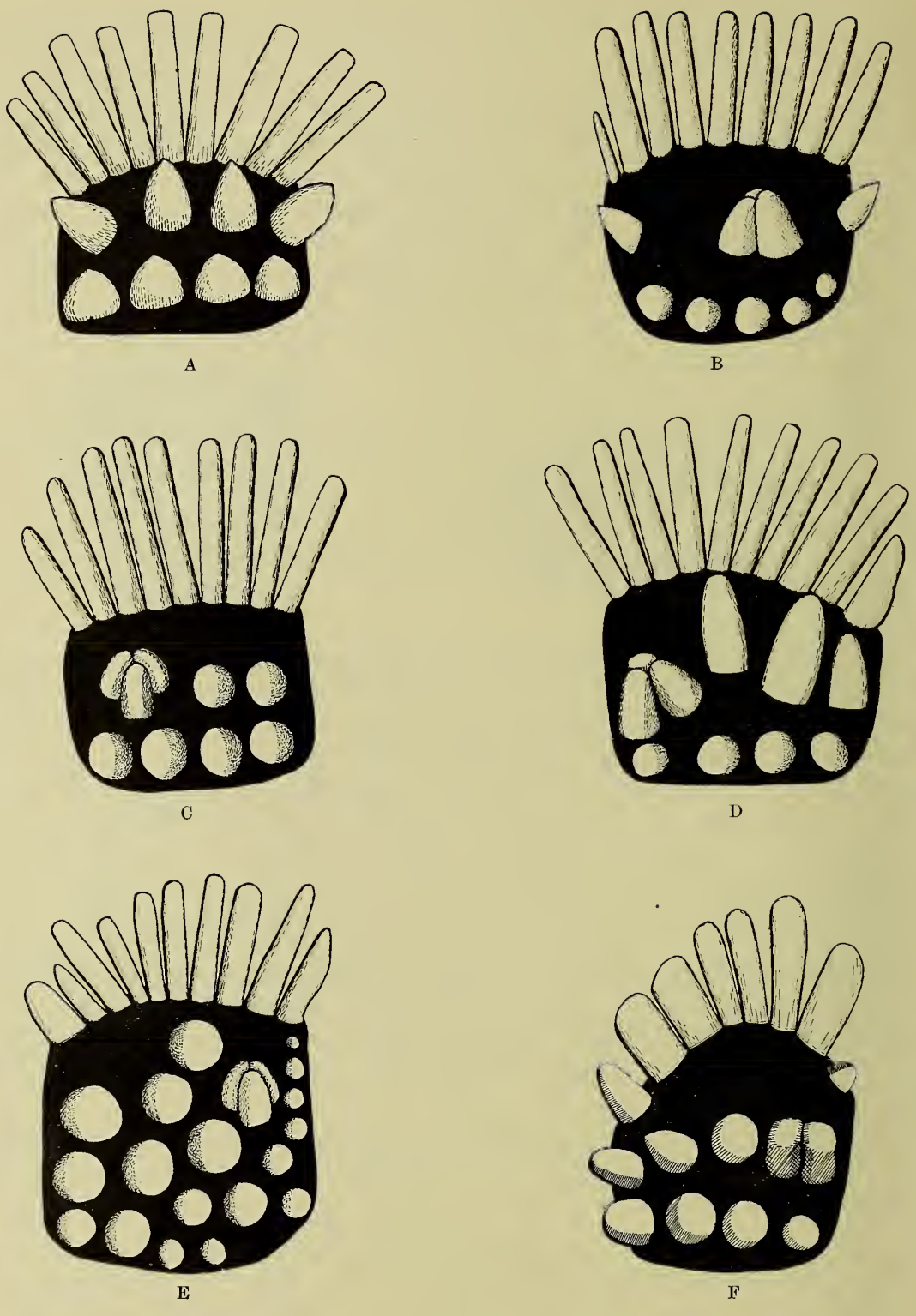
	Plate No. 1.	6.	12.	24.	
Height	1	2	1·5	1·25	mm.
Breadth	3·5	3	2·0	1·25	,,
Length	2·5	3	2·75	1·75	,,

The plates are covered with large hemispherical granules, arranged in about twelve irregular rows. One or two bivalved pedicellariæ are found on nearly every plate in some specimens, while in others they are almost absent. Usually they are sunk in small pits and lie flush with the surface of the plate ; in three examples they are lodged in conspicuous swellings.

The *infero-marginal plates* correspond to the supero-marginals, and resemble them both in the distribution of pedicellariæ and in granulation. The following measurements are taken from specimen No. 98, 11 :

	Plate No. 1.	5.	10.	20.	
Height	1·5	1·5	1·25	0·75	mm.
Breadth	3·75	2·5	1·25	0·5	,,
Length	3	2·75	2·25	1·75	,,

The *actinal intermediate areas* are paved with four chevrons containing successively some 14, 10, 5 and 2 plates. The innermost chevron extends to the fifth or sixth infero-marginal plate. The surface of each plate bears four or five rows of conical granules which



TEXT-FIG. 7.—*Nymphaster mœbii* (Studer). A, 5th adambulacral plate × 33 (No. 95 ; St. 145) ; B, 6th adambulacral plate × 33 (same specimen) ; C, 6th adambulacral plate × 33 (No. 20 ; St. 109) ; D, 7th adambulacral plate × 33 (No. 98, 17 ; St. 122) ; E, 17th adambulacral plate × 33 (No. 40*c* ; St. 108) ; F, 8th adambulacral plate × 33 (No. 100*a* ; St. 184).

may be pointed or rounded at the tip. Some specimens have no pedicellariæ; the majority have between four and twelve, and a few have much larger numbers, the highest being sixty-five. Except in three specimens the pedicellariæ occur only on the plates of the innermost chevron.

The *adambulacral plates* bear furrow spines arranged in a palmate series, with the lateral spines slightly shorter than those in the centre (Text-fig. 7D). Seen from below the spines are straight-sided and truncate at the tip; seen from the side they are tapering and slightly curved. The plate next to the mouth bears seven spines and the number increases on subsequent plates, till, from about the tenth outwards, every plate is armed with eleven spines. The arrangement of the furrow series of spines remains remarkably constant throughout the whole range of specimens; the actinal armature of the adambulacral plates is, on the other hand, extraordinarily variable. A typical plate has two rows of four conical granules, the inner a trifle longer than the outer. The following deviations from this are found: (i) The number of granules may be as low as four or as high as twenty, and according to their number the granules are arranged in one, two or three regular rows, with intermediate stages where the arrangement is less regular. In any one specimen the number of granules is approximately the same for each plate. Intermediate specimens, however, indicate that there is no justification for separating examples with two rows of granules from those with three. (ii) Usually one row of granules is modified to form a two-, three-, or four-jawed pedicellaria. The pedicellariæ may occur on every plate or may be entirely absent. (iii) Sometimes the inner row of granules is slightly elongate. It is possible to trace a series up to the extreme form represented in Text-fig. 7D, where the inner row is definitely spiniform, flattened, and over half as long as the furrow spines. Text-fig. 7 A–F illustrates the different arrangements of the armature of the adambulacral plates. They are taken from specimens in all the lines of variation, but it is found that no separation at all can be effected on this character.

The *mouth plates* are armed with a furrow series of ten or eleven spines similar to those of the adambulacral plates, except for the first two or three, which in transverse section are wedge-shaped instead of rectangular. On the actinal surface some nine to fifteen granules are rather variable in arrangement. There are always two rows, one parallel with the suture between adjacent plates, the other parallel with the suture separating the first adambulacral plate; and there are some granules in the centre, a few of which may form a straight line lying parallel with the furrow spines. The granules are low near the distal end of the plate, but as the mouth angle is approached they show a slight increase in length. Two or three in the corner nearest the mouth are definitely spiniform, wedge-shaped, and nearly as long as the furrow spines.

Smaller Forms.—Twenty-four specimens with a minor radius of between 8 and 12 mm. throw light on the growth changes. Their characters are: R/r 3·7 to 4·4; adambulacral plates with seven to eleven furrow spines and one or two rows of actinal granules; mouth plates with seven to eleven furrow spines and four to twelve actinal granules; supero-marginal plates eighteen to twenty-six in number, six to eight bounding the paxillar area; carinal plates seven to nine in number, granules ten to twenty-eight, the most usual arrangement being twelve peripheral and six central; actinal intermediate areas made up of four chevrons containing usually 7, 4, 2 and 1 plates successively.

Thus, compared with the larger forms the smaller forms have the same R/r ratio, and their mouth plates and adambulacral plates show only a very slight tendency to bear

fewer granules. On the other hand the total number of supero-marginal, carinal and actinal intermediate plates is definitely smaller.

Remarks on Synonymy.—The forms just described are believed to conform with the type of *N. mœbii* (Studer). *N. ternalis* (Koehler) is a synonym according to Döderlein, and the foregoing description also embraces *N. ludwigi* (Koehler), which was separated on the following characters, shown above to be quite unreliable : (i) actinal adambulacral granules in two rows in *N. ludwigi*, in three rows in *N. ternalis* ; (ii) pedicellariæ absent from adambulacral plates in *N. ludwigi*, present in *N. ternalis*.

Variations.—The following four variations differ from the typical form, and might have received specific recognition but for the presence of examples intermediate in character.

Type A.—Pl. IV, figs. 2 and 8, St. 184, Gulf of Aden, 6 specimens, Cat. no. 100 a–f.

The extreme member of the series (No. 100 f) has the following characters : The supero-marginal plates are tumid ; the granules of the carinal plates are fewer in number than in the type ; the adambulacral furrow spines are very short (Text-fig. 7f) ; the actinal surface of the mouth plates is covered by granules which are numerous, round and very low, and not elongated near the mouth angle.

The accompanying table shows that the specimens fall into a series progressively approaching the typical form in character :

Cat. No.	r, mm.	Supero-marginal plates.	Armature of actinal surface of mouth plates.	Adambulacral furrow spines.	Number of carinal granules.
100f	18	Tumid	Papilliform	Very short	29
100c	20	,,	,,	Short	25
100d	20	,,	,,	,,	36
100b	21	Slightly tumid	Slightly elongate and rounded	,,	18
100a	22	,, ,,	Ditto.	,,	26
100e	19	,, ,,	,,	Resembling those of type	23

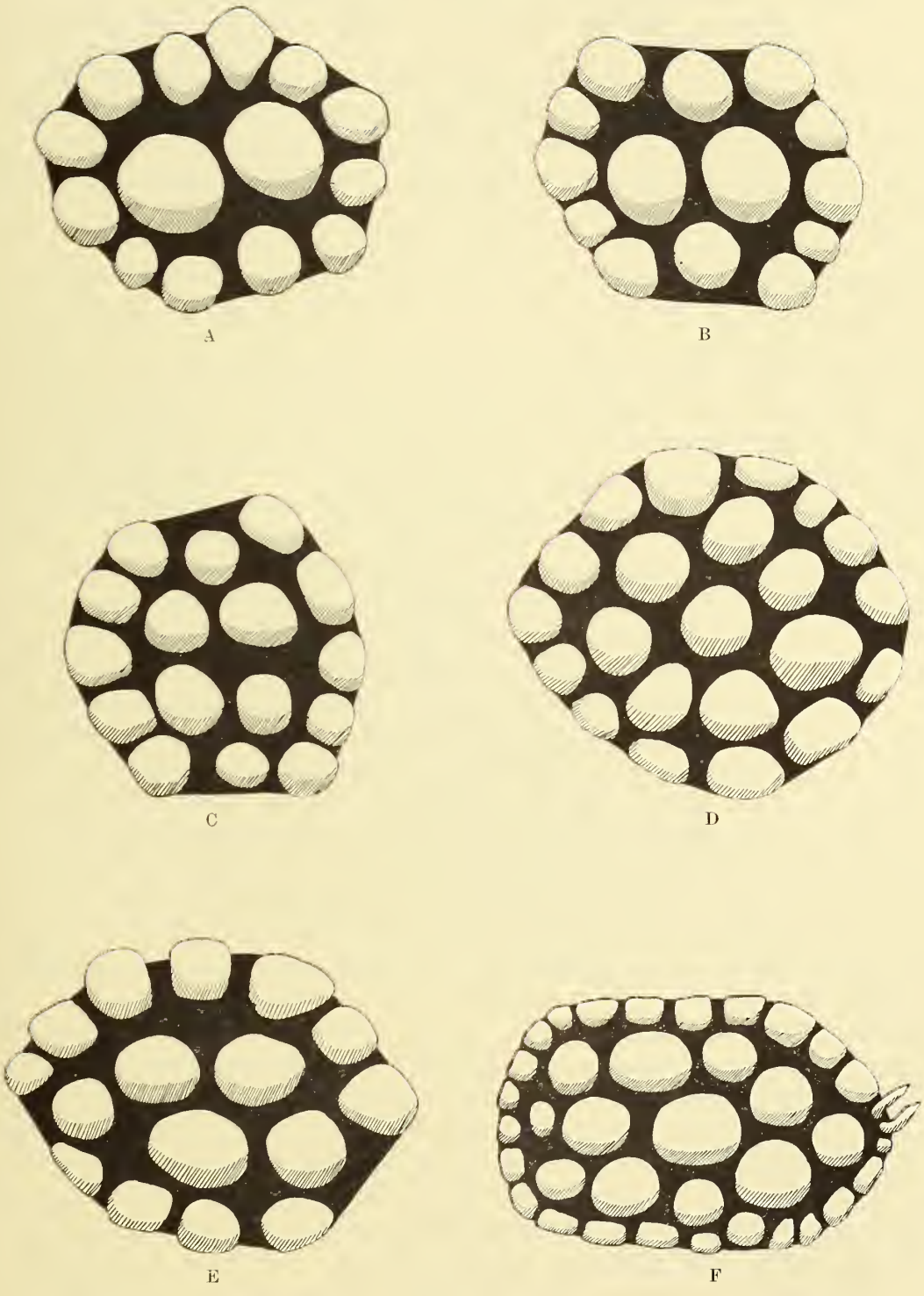
The supero-marginal plates of specimens 100 b, a and e are no more tumid than they may be in the typical form ; the last differs only in its blunt actinal mouth armature and few carinal granules.

These specimens are very like the photographs of *N. alcocki* (Chun, 1900, p. 493), but I have been unable to find a description of this species.

Type B.—Pl. IV, fig. 4, Sts. 105, 108, 110, Zanzibar area, 6 specimens, Cat. no. 17a, c, 40c, 97a, b, c.

No. 17c, the extreme member of the series, differs from the typical form in the following characters : (i) R/r 5·0 ; (ii) the granules surmounting the carinal plates are only fourteen to sixteen in number, of which two to four lie in the centre and the remainder form a peripheral series round them ; (iii) the central granules of the carinal plates are distinctly larger than the peripheral (Text-fig. 8a).

The following intermediate forms occur :



TEXT-FIG. 8.—*Nymphaster mœbii* (Studer). A, 3rd carinal plate × 50 (No. 17*c*; St. 105); B, 5th carinal plate × 50 (No. 97*b*; St. 110); C, 3rd carinal plate × 50 (No. 97*c*; St. 110); D, 3rd carinal plate × 50 (No. 97*a*; St. 110); E, 4th carinal plate × 50 (No. 97*a*; St. 110); F, 5th carinal plate × 25 (No. 40*c*; St. 108).

Cat. No.	r, mm.	R/r.	Number of carinal granules. Peripheral.	Central.	Total.	Relative sizes of carinal granules.
97b	10	4·9	10–14	2–4	12–18	Central larger than peripheral (Text-fig. 8B).
97a	10	5·0	11–17	5–8	16–25	Central slightly larger than peripheral (Text-figs. 8D, and E).
17a	13	4·6	13–15	4–7	17–22	Central larger than peripheral.
40c	25	Arms broken	20–24	10–12	30–36	,, ,, ,, (Text-fig. 8F).
97c	9	Ditto	10–17	6–12	16–29	Central scarcely larger than peripheral (Text-fig. 8C).

It is hoped that the text-figures sufficiently demonstrate that the number and difference in size between the central and peripheral granules of the carinal plates is not a character on which a clear-cut distinction can be based. The R/r ratio varies from 4·6 to 5·0 in this form and from 3·8 to 4·4 in the typical form. The Indian Museum kindly sent me the type of *Nymphaster nora* Alcock and it is found that the present specimens closely resemble this species. Alcock, however, gives the R/r ratio as 6·3 (no arms are whole now), and because of this the species must be regarded as distinct.

Type C.—Pl. IV, fig. 6, St. 122, Zanzibar area, 1 specimen, Cat. no. 98, 16.

No. 98, 16 (r 20 mm.), differs from the typical form in the following characters: (i) Of approximately three hundred actinal intermediate plates one hundred bear pedicellariæ; (ii) the supero-marginal plates are rounded, giving the arms a D-shaped transverse section.

There is, however, an uninterrupted series of forms connecting the round arms of this specimen with the angular arms of the typical form, while the pedicellariæ are unlikely to be of much significance, for another typically round-armed form, No. 98f, has only fifteen, and sixty-five are found on No. 98e, a specimen with typically angular arms.

Type D.—Pl. IV, figs. 3 and 7, St. 145, Maldives, 2 specimens, Cat. No. 95 and 96.

In these two specimens (r 22 and 25 mm.) all the carinals are twice as broad as long and the abactinal surface has in consequence a characteristic facies. Some examples of the typical form, however, approach this condition, and alone it cannot be regarded as a valid specific character.

Koehler's type of *N. belli*, which I have seen, is much smaller than these two specimens, but they are almost certainly one and the same. Koehler separates *N. belli* from *N. ternalis* on the following grounds: (i) *N. ternalis* has a more robust body and stouter arms; (ii) *N. belli* has the carinal plates twice as broad as long, whereas in *N. ternalis* they are roughly hexagonal; (iii) *N. belli* has no pedicellariæ.

Genus *Eugoniaster* Verrill.

The following records exist for this genus:

Species.	Reference.	Number caught.	Locality.	Depth.	Bottom.
E. investigatoris (Alcock)	Alcock, 1893	1	Bay of Bengal	1380 m.	Brown mud.
E. döderleini (Koehler)	Koehler, 1909	1	Minikoi	2160 m.	..

Eugoniaster ephemeralis sp. n. (Pl. II, figs. 2, 4 and 8 ; Text-fig. 9.)

Occurrence :

St. 115, Zanzibar area, 640–658 m. ; 1 specimen.

Diagnosis.—R/r 2. Disk flat, arcuately pentagonal ; arms short, slightly tapering, bluntly rounded at the tip. Abactinal radial plates round or oval, irregularly arranged ; papulæ emerging from spaces between radial plates and extending to a point level with fifth supero-marginal ; interradial plates smaller than radial, angular, with no spaces between them ; all abactinal plates nude except for an occasional small pedicellaria on radials, ornamented with alveolar sculpturing and bordered with truncate granules. Supero-marginal plates eleven, last pair in contact ; plates with rounded outer angles and flat surfaces, except for last four, which are tumid ; abactinal surface with a few granules and some pedicellariæ, lateral surface with many granules ; plates bordered in same fashion as abactinal plates ; size decreasing uniformly except for last three or four plates. Infero-marginal plates corresponding with, and similar to supero-marginals, except that both surfaces are covered with granules. Actinal intermediate areas reaching seventh infero-marginal ; plates in about six chevrons ; plates covered with numerous small round granules, those of innermost chevron usually with small bi-valved pedicellaria as well. Adambulacral plates with about nine short flat spines on the furrow margin and two or three rows of about five granules, with often a bi-valved pedicellaria near the proximal edge, on the actinal surface.

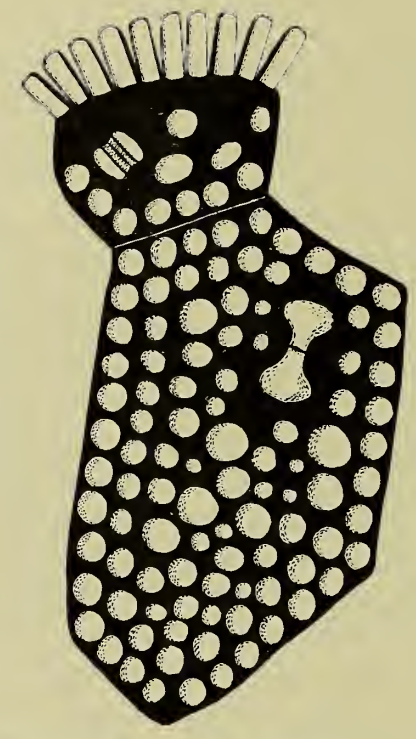
Description.—R 50 mm., r 25 mm. Breadth of arm at level of centre of third supero-marginal plate 11 mm., at level of distal end of eighth supero-marginal 6 mm. The *abactinal radial areas* (Pl. II, fig. 8) are paved with plates which are round or oval, and, therefore, touch each other only at one point, leaving conspicuous triangular or quadrangular spaces, in each of which a papula emerges. The plates are very variable in size, and in consequence fall into no definite linear arrangement in any direction. A section across the radial pore-bearing area at any point will pass through some ten to twelve plates and the breadth of the area is 10 to 13 mm. The plates extend to the last pair of supero-marginals : the papulæ are not found beyond the level of the fifth supero-marginal plate. The plates of the *interradial areas* are a little smaller than the average radial plate and, being angular, fit together without leaving any interspaces. All the plates are naked except for a border of truncate granules and, in some of the radial plates, a small two-valved pedicellaria. The surface is ornamented with an alveolar pattern formed of minute bosses. The *madreporite* is large and encircled by ten plates.

The *supero-marginal plates* number eleven. They have distinct abactinal and lateral faces, but these join at a widely rounded angle. The plates of the interradius and base of the arm are quite flat, but the last three or four, where the tip of the ray turns up, are tumid. The plates are bordered with granules similar to those round the abactinal plates, and the lateral face is closely covered with small round deciduous granules. A few of these granules are found also on the abactinal face, but most of this area is bare except for a few small pedicellariæ in pits. The length of the plates is greater than the breadth, and the breadth is greater than the height. All three dimensions decrease together to the eighth or ninth plate where, owing to the appearance of a median tumidity, the height

and breadth show a sudden increase. The following measurements of supero-marginal plates were taken :

	Plate No.			
	1.	3.	6.	8.
Height	2	2	1·75	2 mm.
Length	4	3·75	3	1 „
Breadth	3	2·75	2	2·25 mm.

The *infero-marginal plates* are the counterparts of the supero-marginals except that they have granules on both surfaces.



Text-fig. 9.—*Eugoniaster ephemeralis* sp. n. Adambulacral and actinal intermediate plate × 50.

The *actinal intermediate areas* are extensive and reach the seventh infero-marginal. There are about six chevrons, the two or three innermost clearly defined, but the remainder becoming more irregular in alignment. The number of plates in the successive chevrons is about 25, 15, 10, 7, 4 and 2. The plates of the first chevron are large, usually six-sided and twice as broad as long (Text-fig. 9). The remainder are smaller, diamond-shaped or irregularly quadrangular. Each plate is bordered by a row of uniform low round granules, while the centre is somewhat closely covered by granules of a similar shape but more variable size, some being larger, some smaller than those of the peripheral series. A small bivalve pedicellaria is found on most of the plates of the innermost chevron.

The *adambulacral plates* are slightly longer than broad, and present to the furrow a uniformly rounded margin on which stand nine to eleven short flattened truncate spines

with their edges directed towards the furrow. The actinal surface bears two, or sometimes three, rows of low round granules, four or five in each row. A bivalved pedicellaria often stands near the proximal border of the plate (Text-fig. 9).

The *mouth plates* have a furrow series of thirteen spines similar to those of the adambulacral plates, while the actinal surface of each is decked with twenty to thirty round granules.

Affinities.—The genus *Eugoniaster*, founded by Verrill in 1899 for the reception of the single species *Pentagonaster investigatoris* Alcock, is separated from related genera by remarkably insignificant characters. Verrill himself (p. 173) says, "The character of the pedicellariæ differentiates the genus from *Tosia* and its closer allies", while Koehler (1909, p. 73), describing *Pentagonaster döderleini*, remarks: "Le *P. döderleini* a des relations avec les espèces du sous-genre *Plinthaster* de Verrill mais elle se distingue des espèces connues telles que les *P. perrieri, nitida, compta*, etc., par les plaques marginales dorsales qui ne sont pas contiguës a leur congénères vers l'extrémité des bras. Le *P. döderleini* me paraît trouver plutôt sa place dans le sous-genre Eugoniaster." The genus *Pontioceramus* Fisher (1911) differs in having the last five supero-marginal plates in contact, very smooth hexagonal abactinal plates, and an angular furrow margin to the adambulacral plates.

The present example is close to *E. döderleini*, but differs in having the arms broader and less pointed, the papular areas more extensive, and granules on the marginal plates. *E. investigatoris* has shorter arms but more supero-marginal plates. The following is a key to the three species:

A. R/r 1·6; supero-marginals 17; furrow spines 6 to 7 . . . . . *investigatoris*.
B. R/r 2·0; supero-marginals 11; furrow spines 8 to 11.
  a. Papulæ ceasing at level of distal edge of 2nd SMP.; surface of marginal plates naked *döderleini*.
  b. Papulæ ceasing at level of distal edge of 4th or 5th SMP.; lateral face of SMPs. and both faces of IMPs. with granules . . . . . *ephemeralis*.

Genus *Lithosoma* Fisher.

The table below shows the recorded occurrences of the species of this genus. All are from the Indo-Pacific region:

Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
L. actinometra Fisher .	Fisher, 1911, 1919	2	2	Philippines	208 m.	Mud, shell and coral sand.
	Döderlein, 1924	1	1	Borneo	538 m.	Dark brown sandy mud.
L. actinometra var. *brevipes* Döderlein	,, ,,	1	1	Timor Sea	520 m.	Grey mud.
L. penichra Fisher . .	Fisher, 1917, 1919	4	4	Philippines	400–800 m.	Green mud; globigerina ooze.
L. pentaphylla (Alcock) .	Alcock, 1893	1	1	Andamans	480 m.	..

Lithosoma ochlerotatus sp. n. (Pl. II, figs. 7 and 9.)

Occurrence :

St. 105, Zanzibar area, 280 m., brown mud ; 1 specimen.

Diagnosis.—R/r 2·5. Body flat ; arms short, wide, blunt at tip ; supero-marginal plates in contact on ray. Abactinal plates regularly hexagonal ; nude except for an occasional pedicellaria on carinals and first laterals and border of small rectangular granules flush with general surface. Six papulæ about each plate in the proximal half of carinal and first lateral rows. Supero-marginal plates bordered in same way as abactinal plates, otherwise naked except for two or three pedicellariæ ; tumid, forming a broad rounded border to arms and disk. Infero-marginals similar to supero-marginals. Actinal intermediate areas small, extending to third infero-marginal ; plates with bordering coarser than that of abactinal and marginal plates, surface naked except for an occasional pedicellaria. Adambulacral plates with five to eight flat furrow spines, of which all but the most distal are set with their edges directed towards the furrow ; actinal surface with a two-, three-, or four-jawed pedicellaria and about four granules on the margin.

Description.—R. 33 mm., r 13 mm. ; breadth of arm at level of fourth supero-marginal plate 8 mm. The first six to eight plates in the carinal and first lateral rows are not in contact with their neighbours and about each one six papulæ emerge ; the remaining plates are all contiguous. Since every plate except those in the carinal row, which are a little broader than long, is an equal-sided hexagon, they lie in an unusually regular arrangement. The carinal row has thirteen plates and the five rows parallel with it 10, 7, 4, 2 and 1 respectively. Round the edge of each plate there is a series of small subquadrangular slightly elongate granules, flush with the general surface, but, except for some of the plates of the carinal and first lateral rows on which two-jawed pedicellariæ occur, there is nothing in the centre, and the bare surface is ornamented with an alveolar sculpturing.

There are ten *supero-marginal plates*, of which the distal seven are contiguous down the ray. The plates are bare except for a marginal series of granules and two or three high spatulate pedicellariæ, which lie close to, and parallel with, the adjacent edges of each plate. All the plates are broader than long, slightly tumid, and their abactinal surface passes into a gentle curve which is continued on the infero-marginals, and gives the animal a rounded border both to the arms and to the disk. The *infero-marginals* are similar to the supero-marginals, but the pedicellariæ lie for the most part parallel with the inner instead of the lateral edges. The breadth of the first two plates is nearly twice the length, but subsequent plates are narrower and those at the tip of the ray are longer than broad.

The *actinal intermediate areas* are small and reach only the third infero-marginal. There are four chevrons, containing successively 7, 4, 2 and 1 plates. These plates are four-sided and their surface sculpturing is similar to that of the abactinal plates, though the granules round the edge are larger. One or two pedicellariæ occur on most of the plates of the innermost chevron and occasionally on other plates as well.

The *adambulacral plates* have a uniformly convex furrow margin. On the first plate there are five furrow spines, and the number increases on successive plates till it reaches

eight. The spines are short and compressed. The proximal spines present their edges, the distal spine of each plate its flat surface, towards the furrow. On the actinal surface there is a pedicellaria with two, three or four jaws, and near the outer margin stand two, three or four granules.

The *mouth-plates* bear six furrow spines and on the actinal surface two rows of granules, of which the two innermost are elongated.

Affinities.—On account of the characters of the abactinal plates with their complete ring of granules, the flat adambulacral furrow spines with the long axis of the most distal at right-angles to that of the rest, and the general abundance of pedicellariæ, I have no hesitation in assigning the present specimen to the genus *Lithosoma*, though the difference between it and *Iconaster* is slight. It is, however, with hesitation that a new species is created, for the difference in size between the present and the two previously described species is considerable. On account of this, characters such as the number of superomarginal plates, the R/r ratio, and the number of furrow spines, *i. e.* the characters wherein the main differences lie, must be treated with the utmost suspicion. It would seem, however, that the discrepancies are so great that they cannot be due entirely to growth changes, and that the present specimen must receive specific recognition.

The following table shows the differences between the three species :

		L. actinometra.	*L. penichra.*	*L. ochlerotatus.*
	R	155 mm.	86 mm.	33 mm.
	R/r	3·7	4·0	2·5
Adambulacral plates.	Furrow margin	6–11 spines, margin convex	5–10 spines, margin angular	5–8 spines, margin convex.
	Actinal surface	One to three 2-jawed pedicellariæ	One 2- or 3-jawed pedicellaria	One 2-, 3- or 4-jawed pedicellaria.
	Number of SMPs.	40	32	10
	Papulæ	All over disk	Confined to radial areas	Confined to radial areas.
	Abactinal pedicellariæ.	Very small	Small	Small.
	Act. int. areas	Irregular	Irregular	Regular.

Remarks.—Fisher (1919, p. 301) regards the species described by Alcock under the name of *Dorigona pentaphylla* as very close to, or possibly identical with, *Lithosoma actinometra*.

Describing *Iconaster gardineri*, Bell (1909, p. 22) remarks : " There are three specimens of different size in this genus and I may remark that one of them is so minute that it does not exhibit the leading characters of the genus." Fisher (1919, p. 309) refers to this species as " typical *Nymphaster* related perhaps to *N. dyscritus* Fisher ". I have examined Bell's three specimens at the British Museum. The two larger undoubtedly are *Nymphaster*, but the small one has naked plates throughout and is not. It is close to the present genus.

Genus *Astroceramus* Fisher.

The following records, all from the Indo-Pacific region, exist for this genus :

Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
A. callimorphus Fisher	Fisher, 1906	1	1	Hawaiian Is.	230 m.	Fine sand, yellow mud.
A. lionotus Fisher	,, 1913	1	1	Philippine Is.	..	..
A. sphæriosticus Fisher	,, ,,	1	1	,, ,,	292 m.	Coral sand.
A. fisheri Koehler	Koehler, 1909	3	1	Between Maldive Is. and Colombo	400–500 m.	..
	Döderlein, 1924	1	1	Moluccas	827 m.	Hard ground.

Astroceramus cadessus sp. n. (Pl. II, figs. 3 and 5 ; Text-fig. 10.)

Occurrence :

St. 157, Maldives, 229 m., coral rock ; 2 specimens.

Diagnosis.—R/r 2·8. Disk flat ; arms tapering, rectangular in cross-section ; interbrachial arcs widely rounded. Abactinal plates hexagonal, regularly arranged ; bare centrally, bordered with truncate granules. Supero-marginals in contact along arms ; slightly tumid on disk, flat on arms ; bordered similarly to abactinal plates ; lateral surface with hemispherical deciduous granules. Infero-marginals corresponding to supero-marginals only in interradius and at tip of ray ; bordered in similar fashion but with granules on both lateral and actinal faces. Actinal intermediate plates in three chevrons, the outermost enclosing an irregularly arranged group ; bordered with granules coarser than those of abactinal and marginal plates ; centre with one to six granules a little larger still ; pedicellariæ on plates of innermost chevron. Adambulacral plates with furrow series of six or seven flattened spines and with two series on actinal surface, the inner of a granule and two spines, one large flattened rounded at the tip, the other similar but barely half the size, the outer series of four or five truncate or pointed granules.

Description.—R 50 mm., r 18 mm., R/r 2·8 ; R 35 mm., r 12 mm., R/r 2·9. The *abactinal plates* are regularly arranged, hexagonal in shape and a little broader than long. There are about fourteen carinal plates and on either side three well-defined rows of similar but somewhat smaller plates. Beyond them there is a triangular area in which the plates, about thirty in all, are more irregular both in outline and arrangement. All the abactinal plates are quite bare centrally, ornamented with an alveolar sculpturing and bordered by small subtruncate granules flush with the surface. A papula emerges at the corner of each plate except of those in the centre and in a small triangular region within the interradial area.

There are fourteen *supero-marginal plates*, of which the distal eleven are in contact with their opposites down the length of the ray. The abactinal and lateral faces meet at a right-angle ; the former is flat on the arms and slightly convex on the disk. There is a granular border similar to that of the abactinal plates, and the lateral face is closely

covered with about twenty-five deciduous hemispherical granules. Some of these encroach on to the abactinal surface of the first few plates, but are absent from this region of the remainder. The length of the plate is greater than the height throughout. The breadth is equal to the length in the first plate, becomes greater at the base of the arms and then equal again, from which point all three dimensions decrease uniformly to the tip of the ray. Measurements taken from the larger specimen are :

	Plate No. 1.	4.	8.	12.	
Height. . .	2·5	2·5	1·75	1·5	mm.
Length . .	3·25	3·25	2·5	1·75	,,
Breadth . .	3·25	4	2·5	1·75	,,

The *infero-marginal plates* are longer than the supero-marginals and only correspond to them in the interradius and at the tip of the ray. Their bordering and granulation is similar except that granules occur on both faces. The dimensions of plates from the larger specimen are :

	Plate No. 1.	4.	8.	12.	
Height. . .	2	2	1·5	1	mm.
Length . .	3·25	3·75	2·75	2	,,
Breadth . .	3·5	2·5	1·25	1	,,

The terminal plate is armed with three short spines.

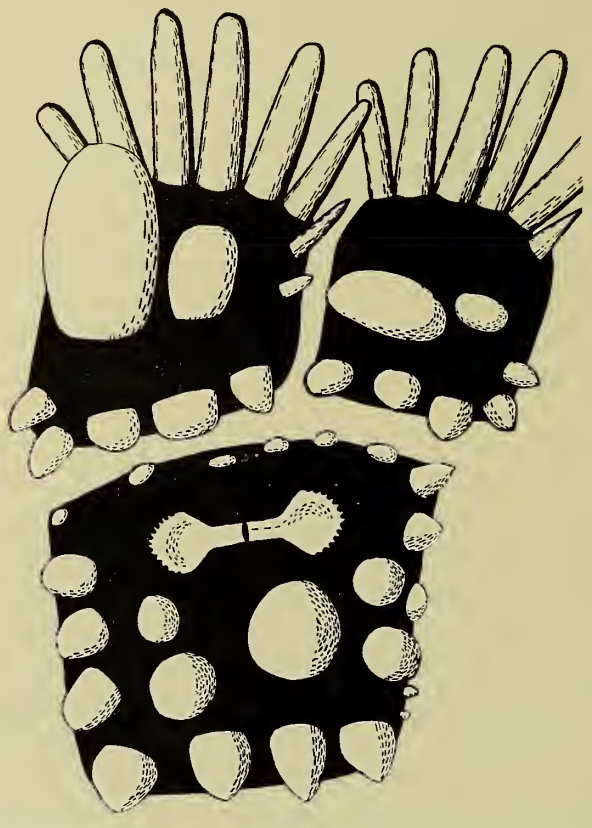
Actinal intermediate areas.—It is possible to make out three chevrons containing successively 11, 7 and 4 plates. The outermost of these chevrons encloses about ten plates falling into no regular order. The edge of each plate bears a series of bordering granules, which are more variable in size, though on the average larger and more spaced, than those of the abactinal and marginal plates. The centre of the plate is occupied by one to six hemispherical granules, a little larger than those of the peripheral series, and on the plates of the innermost chevron a bivalved pedicellaria usually occurs as well (Text-fig. 10).

Adambulacral plates.—There are six or seven furrow spines. The adoral is smaller, more pointed than, and set back a little from the rest, which are long delicate flattened and rounded at the tip. On the actinal surface there is an inner series consisting of a small pointed granule and two spines, the larger very broad, as long as the furrow spines, flattened and rounded at the tip, the second similar but barely half the size, and an outer series consisting of four or five pointed or subtruncate granules (Text-fig. 10).

The *mouth plates* have a furrow series of nine spines, similar to those of the adambulacral plates, and their actinal surface is traversed by two rows, of which the first, parallel with the suture between adjacent plates, consists of four granules distally and two wedge-shaped spines proximally, and the second, parallel with the suture between the mouth plate and first adambulacral, consists of two granules. Inside the triangular area enclosed by these two series and the furrow spines there is a single enlarged spine similar to those on the adambulacral plates.

Colour.—In spirit: white with a line of red-brown pigment running between all the plates of the abactinal surface. In the smaller specimen there is a patch of similar but rather lighter colour on the abactinal surface of each of the first two supero-marginal plates.

Affinities.—The species is, perhaps, related to the Hawaiian form, *A. callimorphus*, but the arms are shorter, in which character it is intermediate between *A. callimorphus*



Text-fig. 10.—*Astroceramus cadessus* sp. n. Adambulacral and actinal intermediate plates × 50.

and *A. fisheri*. Other characters by which it may be distinguished from the former lie chiefly in the adambulacral armature, for *A. callimorphus* has more actinal granules, fewer furrow spines and the enlarged actinal spines subequal. *A. fisheri* is distinguished at once by the fact that out of a total of thirteen supero-marginals five bound the paxillar area and only eight are in contact. In *A. cadessus* three supero-marginals out of a total of fourteen bound the paxillar area of the disk. The differences separating the five known species are expressed in the accompanying key:

I. Ratio of number of SMPs. bounding paxillar area to total number of SMPs. less than 1 : 3 . *fisheri.*
II. Ratio of number of SMPs. bounding paxillar area to total number of SMPs. at least 1 : 5.
  1. R/r 2·8; furrow spines 6 to 7 . . . . . *cadessus.*
  2. R/r greater than 3; furrow spines 4 to 5.
    i. Abactinal surface without granules:
      A. Furrow spines sligthly compressed, truncate . . . . . *callimorphus.*
      B. Furrow spines strongly compressed, broadened at tip . . . . *lionotus.*
    ii. Abactinal surface with granules . . . . . *sphæriosticus.*

Genus *Milteliphaster* Alcock.

Milteliphaster wood-masoni Alcock.

Milteliphaster wood-masoni, Alcock, 1893, p. 91, pl. vi, figs. 5, 6, 7.

Occurrence :

St. 157, King Fuad Bank, Maldives, 229 m., coral rock ; 2 specimens.

Distribution.—Andaman Sea ; Maldives ; 229–529 m.

Remarks.—Alcock's description states : " Each supero-marginal carries . . . a large coarse spine . . . at the tip of the ray the plates have two spines . . . a few of the plates also have one of the large pedicellariæ." The smaller specimen agrees with this description except that most of the supero-marginal plates are armed with two spines. In the larger specimen some of the supero-marginals bounding the paxillar area, and all beyond the sixth or seventh plate, are armed with two spines, and many of them, particularly those about the paxillar area, bear two or even three pedicellariæ. Further, in the larger specimen the supero-marginals do not all lie laterally and vertically, as in the type described by Alcock and in the smaller specimen, but along most rays and in some interradii as well they are abactinal and almost horizontal.

Alcock's type has nine or ten furrow spines. The smaller of the two present specimens has nine on every plate, while the larger has ten furrow spines on the proximal plates and the number increases on subsequent plates till it reaches fourteen.

The dimensions of the two specimens are R 83 mm., r 23 mm., R/r 3·6 ; R 80 mm., r 23 mm., R/r 3·5.

Genus *Mabahissaster* gen. n.

Diagnosis.—Arms five ; disk pentagonal ; arms moderately long, composed abactinally of supero-marginal plates only. Abactinal plates large, irregularly polygonal, bare except for a border of granules, an occasional pedicellaria and a large coarse spine on many plates in the proximal region of each radial area. Supero-marginal plates bare except for a border of granules, armed with one or two large spines. Infero-marginals similar except that surface may bear granules. Actinal intermediate areas rather small ; plates with border of granules, centre occupied by granules, a pedicellaria on a raised tabulum or a spine. Adambulacral plates with numerous furrow spines ; actinal surface with granules, pedicellariæ and spines.

Remarks.—The granulation of the plates and the presence of numerous distal supero-marginal plates in contact suggests affinities with *Astroceramus* and related genera. None of these, however, bear abactinal or marginal spines. This feature of the genus *Mabahissaster* recalls *Milteliphaster* and *Calliaster*, but in both these genera the supero-marginals are separated by rows of abactinal plates.

Mabahissaster zengi sp. n. (Pl. VI, figs. 1 and 2 ; Text-fig. 11.)

Occurrence :

St. 106, Zanzibar area, 183–194 m., green mud ; 1 specimen.

Diagnosis.—R/r 3·3. Disk fairly thick, slightly raised abactinally, slightly concave

actinally. Arms rather narrow, tapering slowly to a blunt tip. Interbrachial arcs widely rounded. Abactinal surface beset with rather large polygonal, rectangular or round plates ; in radial areas plates varying much in size, in five regular radial rows ; in interradial areas plates smaller and irregular in disposition ; robust tapering spines on about half total number of carinal plates, becoming progressively scarcer on first and second lateral rows of plates ; plates nude except for border of subtruncate granules ; pedicellariæ on many radial and some interradial plates. Supero-marginal plates with well-marked abactinal and lateral surfaces ; plates of arm in contact ; outer edge bearing coarse spine similar to those of abactinal plates, a second similar spine near inner edge of first two plates ; border of granules, surface nude. Infero-marginal plates corresponding to supero-marginals except towards tip of ray ; similar but with spines fluted near tip, and scattered granules on actinal surface. Actinal intermediate areas small, plates rather indefinitely arranged ; border bearing subtruncate granules, centre occupied usually by large pedicellaria set on tabulum, sometimes by granules, very occasionally by fluted spine. Adambulacral plates with seven to nine short crowded furrow spines ; border of plates bearing granules, centre usually occupied by about six granules, one fluted spine and one pedicellaria.

Description.—R 82 mm., r 25 mm. *Abactinal surface.*—The centre of the disk is occupied by a spine-bearing plate whose diameter is 3·75 mm. Around this plate there is a ring of nine plates, five radial and four interradial. Each radial plate is about 2·5 mm. in diameter and is armed with a spine, while the interradials are slightly smaller, about 2 × 2·5 mm., oval in shape and unarmed. The five largest plates of the disk, each armed and measuring about 4 × 5 mm., lie on the interradial line just outside the ring of plates. All these interradial plates are longer than broad. Co-serial with the radial plates of the ring the carinals, fifteen to eighteen in number, extend to the proximal edges of the fifth supero-marginal plates. The plates are broader than long, polygonal or rectangular in shape and the edges are rounded. The sequence of plates is not identical along each radius, but the following description covers three radii ; the fourth is similar except that a small unarmed plate separates the first carinal from the radial plate of the ring. The first plate measures about 3 × 3·5 mm. and bears a spine, the second plate is narrow and unarmed and the third to seventh plates all bear spines. The first of these five plates is usually the largest in the carinal row and measures about 4 × 3·75 mm. Each of the others is usually a little narrower than the plate on the proximal side of it. The eighth plate is narrow and unarmed, the ninth is armed, and the rest of the carinals, six to eight in number, are without spines, much compressed and measure about 3 × 1·25 mm. A small diamond-shaped plate may lie isolated between the fifth and sixth supero-marginals.

The plates of the first lateral row are smaller than those of the carinal, and more or less rounded in shape. The first two are small, 1 to 2 mm. in diameter, and usually unarmed. The third is commonly the largest, 3·25 mm. in diameter, and the remainder decrease gradually in size to the proximal end of the fourth supero-marginal where the series ceases. There are fifteen or sixteen plates, and of the first six, three or four bear spines. The second lateral row is less regular. There are ten or eleven plates, a little smaller than those of the first lateral row. One or two bear spines.

In the interradial area lie about twenty-five small polygonal or rounded plates, 1 to 2 mm. in diameter. They are without spines, though some may bear a small central tubercle.

The abactinal plates present a slightly convex smooth surface round which is a border of flat subtruncate granules. The spines are borne on raised bosses. The base of the spine is rounded and tapers rather rapidly. About a third of the way up the rate of taper becomes less and continues evenly to a fine rounded point. The spines are 4 to 6 mm. high. A few of the interradial plates have a single pedicellaria, and on many of the radial plates, both armed and unarmed, there are one or two pedicellariæ, which consist of a short stalk suddenly flaring into a broad kidney-shaped jaw. They lie in shallow depressions, and when wide open measure a little over 1 mm. from the tip of one jaw to the tip of the other.

The *supero-marginal plates* number fourteen or fifteen. The fifth pair are in contact across the base of the ray. They form a broad sloping border to the paxillar area and a broad flat roof to the rays. Dimensions are :

	Plate No.					
	1.	3.	5.	7.	10.	14.
Height	3	3·5	3·5	3	2·5	1·5 mm.
Length	4	5	5	4·5	4	2·5 ,,
Breadth	7	5	6	4·5	4	2·5 ,,

It will be seen that the height is small but increases slightly up to the fifth plate. The breadth of the first plate is greater than the length, but on subsequent plates it decreases and the length at first increases slightly, so that from the third plate outwards the two dimensions of all plates except the fifth, which are the first pair to meet abactinally, are equal. The outer free border of each plate rises gradually into a large swelling, on which stands a spine resembling the spines of the abactinal plates. A second similar spine stands near the inner border of the two plates on either side of the interradial line. The plates are naked, but bordered with granules similar to those round the abactinal plates. There is no trace of pedicellariæ.

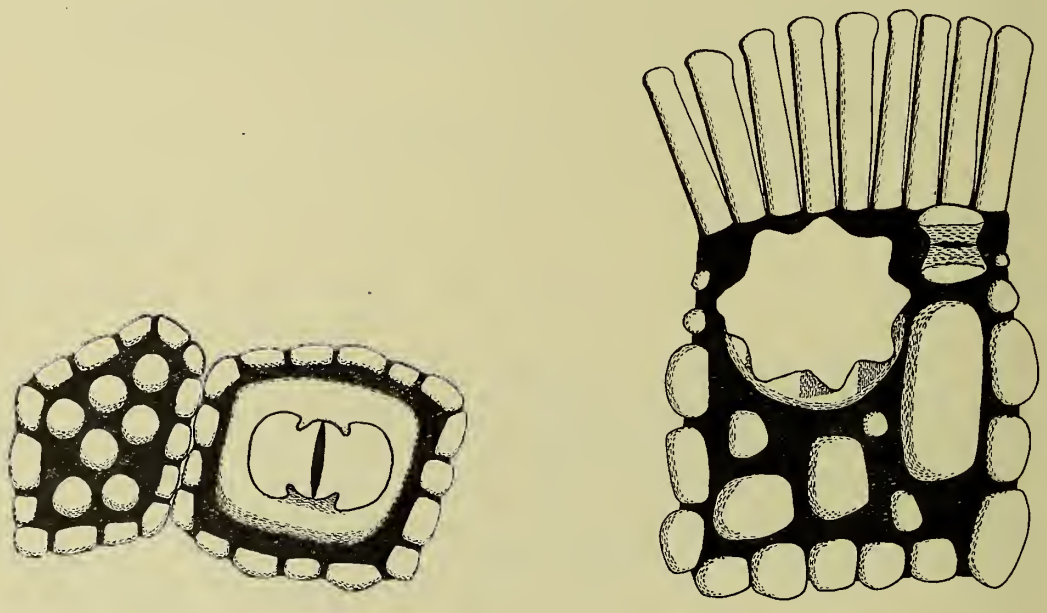
The *infero-marginal plates* correspond to the supero-marginals except towards the tip of the ray, where they become a little longer. Here, also, they are almost confined to the side wall. Dimensions are :

	Plate No.				
	1.	3.	6.	9.	13.
Height	3	3	2	1·5	1·5 mm.
Length	5	5	5	4·5	4 mm.
Breadth	4·5	4·5	2·5	2	1 ,,

The outer edge of each plate bears a spine similar to those of the supero-marginals except for the fact that the outer third is fluted. The plates are bordered with granules, but on the inner edge of the first two or three plates a second and sometimes a third row of granules lies inside the bordering series. Scattered granules or isolated groups occur elsewhere on the actinal surface of the plate. The first two plates bear pedicellariæ.

The *actinal intermediate areas* are small and extend only to the centre of the third

infero-marginal. The plates are irregularly quadrangular, about 2 mm. across. An inner chevron of about nine plates is definite, the next one has five or six plates in less regular order, and outside it there are four or five plates which are not clearly arranged in chevrons. Around the edge of each plate there are ten to twenty flat subtruncate granules, and the centre is usually occupied by a blister-like tabulum on which is lodged a pedicellaria, similar to those of the abactinal plates but twice as large. When there is no pedicellaria the surface of the plate is partially or wholly covered with rather low coarse hemispherical or angular granules (Text-fig. 11A). Two plates in one interradius and one in another bear a spine, 3·5 mm. long and fluted at the tip.



A B

TEXT-FIG. 11.—*Mabahissaster zengi* sp. n. A, Actinal intermediate plates × 12·5; B, Adambulacral plate × 25.

The *adambulacral plates* (Text-fig. 11B) bear seven to nine short flattened closely crowded furrow spines, slightly swollen at the tip. Round the edge of each plate there are about fifteen flat subtruncate granules. The outer half of the actinal surface is occupied by about six low angular granules, and near the proximal border there is a tabulum, similar to, though smaller than, the structure on the actinal intermediate plates. It is possible that these tabula represent a group of granules fused together. Between the tabulum and the furrow spines there is a pedicellaria, and on its distal side a coarse cylindrical spine which is 4 mm. long and has a fluted tip. Occasionally either the spine or the pedicellaria is absent, and some plates have two spines, one outside the other, and a pedicellaria may or may not be present as well.

The *mouth plates* bear twelve to fifteen furrow spines, and on the actinal surface there are some scattered granules and a single spine.

COLOUR.—Abactinal face, army brown with the spines a little darker; actinal face pale flesh-coloured; the two colours merging along the side of the disk and arms.

Sub-family Anthenoidinæ.

Genus *Stellaster* Gray.

Döderlein (1935, p. 86) gives a revision of this genus.

Stellaster equestris (Retzius).

Asterias equestris, Retzius, 1805, p. 12.
Stellaster childreni, Gray, 1840, p. 278.
Stellaster equestris, Müller and Troschel, 1842, p. 128, pl. iv, fig. 3, pl. vi, fig. 5; Goto, 1914, p. 411, pl. xiii, figs. 213–218, pl. xiv, figs. 219, 220; Döderlein, 1935, p. 91.

Occurrence:

St. 72, Gulf of Oman, 73 m., coarse sand and shells; 16 specimens.

Distribution.—Japan (Lütken, Müller and Troschel, Gray). China (Gray, von Martens), Formosa Strait and South China Sea (Lütken). Sonda Islands and Andaman Islands (Koehler). Red Sea (Dollfus); Gulf of Oman.

Description.—R 56–68 mm., r 21–25 mm., R/r 2·5–2·8. The *pores* occur in groups of two or three between the radial plates, and in groups of about ten between the radial and supero-marginal plates. They extend nearly to the tip of each ray, and a few are also found between the plates in the centre of the disk and in the interradial areas. All the specimens have a *tubercle*, or at least the scar from which a tubercle has been rubbed, on the first carinal plate, and a few have a second placed on the third carinal of each radius. A single specimen has three tubercles on one radius, but it has been rubbed so badly that it is not possible to make out if the same condition obtained on any of the other arms.

The *supero-marginal plates* number fifteen to seventeen. Each one is slightly tumid and finely granular, and on most one or two sunk elongate pedicellariæ are found. The *infero-marginal plates* correspond to the supero-marginals, and each is armed with a flattened mobile spine.

The *actinal intermediate plates* are about forty in number. They are arranged in two chevrons, the inner containing ten, the outer seven plates, which enclose one or two odd plates.

The *adambulacral plates* bear a furrow series of five or six short spines, arranged in a palmate group united by membrane at the base. On the actinal surface stand two large flattened spines which are sometimes subequal, though usually one is three times as long as the other. A two-jawed pedicellaria occurs near the proximal edge of most plates.

Genus *Stellasteropsis* Dollfus.

Stellasteropsis colubrinus sp. n. (Pl. V, figs. 2 and 5.)

Occurrence:

St. 24, Gulf of Aden, 73–200 m., coarse sand and shingle; 1 specimen.
St. 27 ,, ,, 37–91 m., sand and shingle; 2 specimens.
St. 45, Arabian coast, 38 m., Lithothamnion; 26 specimens.
St. 53, ,, ,, 13·5 m., rock, shell, shingle and Lithothamnion; 1 specimen.

Distribution.—There are in the British Museum two specimens which belong to this species. They bore the following labels :

"*Stellaster*, 87. 6. 5. 4. Muscat, Col. Miles."

"*Stellaster* yg. 1903, 4. 2. 53. Wasin, coll. Crossland."

Diagnosis.—R/r 3. Body star-shaped ; arms tapering, their sides straight, meeting at an angle at apex of interbrachial arcs. Abactinal surface slightly raised along radii, actinal surface flat. Abactinal plates in regular central, interradial and radial series ; papulæ emerging from between latter. Supero-marginal plates tumid ; last pair in contact. Infero-marginal plates nearly flat ; last four or five plates with tubercle on outer distal corner. Actinal intermediate plates gently convex, unarmed ; arranged in about three chevrons and one or two rows of small plates parallel with infero-marginals. Adambulacral plates and mouth plates bearing only a furrow series of short flat spines which form a continuous palisade roofing adambulacral grooves throughout their length. Entire body covered by membrane and bearing close-set granules ; granules progressively larger on the abactinal, marginal, actinal intermediate and adambulacral plates ; pedicellariæ absent.

Description.—The following description is taken from the largest member of the collection, the single specimen from St. 53. Its dimensions are : R 55 mm., r 18 mm., R/r 3·0. Measurements of arms :

	SM Plate No.					
	1.	3.	6.	9.	15.	
Breadth of ray . . .	20	16	10·5	7·25	4·5	mm.
Breadth of paxillar area	10	8	4	2	0·75	,,

Abactinal surface.—There is a single plate, with the anus to one side of it, lying in the centre of the disk. Around this plate lies a ring of six plates and outside again a ring of ten plates, five radial and five interradial. There is only one other interradial plate which, compressed and lozenge-shaped, lies completely surrounded by three pairs of plates. These plates which are larger than their neighbours and have papulæ only on the side away from the interradial line are the first plates of the three lateral radial series. The carinal plates, which are hexagonal or oval and broader than long, number thirty-two and extend to the last pair of supero-marginal plates. Parallel with them are three rows of similar but slightly smaller plates. In the first row there are fifteen plates reaching the seventh supero-marginal, in the second seven plates reaching the fourth supero-marginal and in the third only three small plates. About the plates near the centre of the disk as many as ten papulæ may emerge, but the number per plate decreases along the ray and the papulæ cease in the neighbourhood of the twentieth carinal plate. The abactinal surface is covered with membrane in which is lodged a number of close-set polygonal granules, of which a single series round the edge of each plate is somewhat enlarged. The rims of the pores are also surrounded by enlarged granules.

The *supero-marginal plates* number seventeen, and all, except the last pair, are separated by abactinal plates. Each one is strongly tumid. A widely rounded angle joins the abactinal and lateral faces which lie respectively horizontally and vertically. At the apex of three of the interradii lie a pair of plates, while at the apex of the other two there is a single unpaired plate. Each one of these eight plates is truncately triangular. The remaining supero-marginals are rectangular when viewed from the abactinal surface. The dimensions of the plates are :

	Plate No. 1.	3.	6.	9.	12.	
Height	4	4	3	2	1·5	mm.
Length	2–4	3·25	2·5	2·25	2·25	,,
Breadth	5	4·5	3·5	3	2·25	,,

The plates are covered by a membrane in which is embedded a close granulation, a little coarser than that of the abactinal plates. The granules are all of one size except for those in the two rows which run round the edge of the plate. These are larger, and form a margin which is particularly conspicuous between the plates.

The *infero-marginal plates* correspond to the supero-marginals but their height is less and they are almost flat. The granulation is similar. The outer distal corner of the last four or five plates is produced into a short papilliform tubercle.

The plates of the *actinal intermediate areas* are rather irregularly disposed. The innermost chevron of fifteen to seventeen plates, reaching the sixth or seventh infero-marginal plate, is quite definite, but the next two with about nine and four plates respectively are less well marked. The rest of the plates are small, number about five, and lie in one or two rows parallel with the infero-marginals. Each plate has a gently convex surface covered with membrane in which the granules are uniform and a little coarser than those of the marginal plates.

The actinal surface of the *adambulacral plates* and the *mouth plates* is covered with granules distinctly coarser than those of the actinal intermediate plates, while the furrow margin bears four or five short flattened truncate spines. The axis of flattening is parallel with the furrow, and the spines stand in an uninterrupted palisade which roofs in the ambulacral groove throughout its length.

Young Forms.—Twenty-six specimens were taken at St. 45, but the largest, with R 37 mm., is a good deal smaller than the single example from St. 53, described above. There are certain noticeable differences between the specimens from the two stations: (i) in all the smaller specimens the interbrachial arcs are rounded; the marked angle of the larger specimen is never seen; (ii) the arrangement of papulæ is very regular in all the smaller specimens, there being one at each corner of the hexagonal radial plates. As many as ten about a plate are found in the larger specimen; (iii) the majority of the smaller specimens have a pair of plates at the apex of each interradius. Single plates such as occur in the larger specimen are found in only three of the twenty-six.

These three points are probably variations and independent of growth. The changes believed to be due to growth are tabulated below: (i) The R/r ratio shows a steady increase, thus; R 8 mm., R/r 2·3; R 37 mm., R/r 2·8; R 55 mm., R/r 3·0. (ii) The number of plates shows the following increase:

R	8	12–22	23–37	55 mm.
Number of carinals	11	14–17	24	32
Number of 1st laterals	4	..	..	15
Number of SMPs.	5	..	..	17

In the smallest specimen (R 8 mm.) the actinal intermediate areas are paved with two chevrons, containing respectively four and two plates.

Affinities.—I have compared the largest member of the present collection with the syntype of *Stellasteropsis fouadi* Dollfus (1936) in the British Museum. The two specimens are almost exactly equal in size, and in the number and arrangement of plates they are almost identical. It is found, however, that the present examples have much more tumid supero-marginals than *S. fouadi*, and differ further in that the distal infero-marginal plates bear tubercles, and pedicellariæ are absent. These features are small and might well fall within the range of variation of a single species, but in the absence of intermediate forms it is felt that this view is not justified, and a new species, *S. colubrinus*, has been created.

Stellasteropsis tuberculiferus sp. n. (Pl. V, figs. 4 and 7.)

Occurrence :

St. 45, Arabian Coast, 38 m., Lithothamnion ; 1 specimen.

Diagnosis.—General form similar to *S. colubrinus*, but arms less tapering and broader at tip ; interbrachial arcs rounded. Abactinal plates in regular central, radial and inter-radial groups ; covered with membrane with a close uniform granulation ; tubercles on many radial plates. Pores extending nearly to tip of ray, absent only about plates on interradius. Supero-marginals similar in shape to those of *S. colubrinus* ; differing in that granulation becomes coarser towards centre of plate, and plates of distal half of ray bear one or two tubercles. Lateral face of infero-marginals with a group of enlarged granules of which, on the distal half of the ray, two to four become further enlarged and project as tubercles. Actinal intermediate areas rather small ; plates convex, with granules which become larger as the centre of the plate is approached. Adambulacral plates, as in *S. colubrinus*, with only coarse granules actinally, and a furrow series of five spines roofing in the furrow.

Description.—The specimen has the following dimensions : R 44 mm., r 16 mm., R/r 2·7.

	SM Plate No.				
	1.	3.	6.	11.	13.
Breadth of arm . . .	16	13·5	9	5·5	4 mm.
Breadth of paxillar area . .	11	6	3·5	1·25	..

The anus, the position of which is marked by a ring of tooth-like granules, is surrounded by four small plates. Around these lie eight plates, of which five are radial in position. Co-serial with these latter, twenty-two carinal plates extend to the last pair of supero-marginals, which are in contact. In shape the carinals are hexagonal, the breadth slightly exceeding the length. Thirteen plates, reaching the eighth supero-marginal, and six plates, reaching the fourth supero-marginal, make up the first and second lateral rows respectively. Three small plates, reaching the second supero-marginal, may be said to make up a third lateral row. In the interradius the arrangement of plates is variable. Usually there are four large median plates, but some of these may be replaced by a pair. The plates are covered with membrane in which is embedded a close uniform granulation. In the centre of the proximal seven to nine plates of the first lateral row, the proximal three or four plates of the second lateral row, and a few carinals, there is a short tubercle whose diameter is three or four times that of the granules which lie around it.

Papulæ emerge everywhere except around the interradial plates and the last three or four carinals. Eight to ten papulæ occur around the proximal six to eight plates, six around the next six plates, and four around the next four plates of the carinal row. A similar distribution of papulæ is found around the plates of the first and second lateral rows, though, of course, here the numbers fall off more rapidly.

The *supero-marginal plates* number fourteen. Each one is broader than long, and tumid with a widely rounded angle between the abactinal and lateral faces. Around the edge of the plate the granules are equal in size to those of the abactinal plates, but as the central line of the plate is approached the granules increase to two or three times the size of those at the edge and also become more widely spaced from one another. The last five or six plates bear one or two tubercles on the outer distal corner.

The *infero-marginal plates* correspond to the supero-marginals, but their height is a little less and they are not tumid. The granulation of the actinal face is uniform and similar to that which is found at the edges of the supero-marginals. The lateral face bears a group of about a dozen enlarged granules, of which two to four on the last five or six plates develop further and project as tubercles some 0·5 mm. long.

The *actinal intermediate plates* are arranged in the same rather irregular manner as those of *S. colubrinus*. There are three chevrons, the first well defined, the remaining two less so, and a few plates lying in a row parallel with the infero-marginals. Eleven plates, reaching the fifth infero-marginal, make up the innermost chevron, and about six and three plates respectively the other two. The plates are convex and closely covered with granules, which become larger as the centre of the plate is approached. The granulation of the actinal surface of the *adambulacral plates* is uniform, the granules being equal in size to those in the centre of the actinal intermediate plates. The furrow spines, about five to a plate, form a sloping roof over the furrow and are very like those of *S. colubrinus*.

Affinities.—In general characters there is a close resemblance between *S. colubrinus* and *S. tuberculiferus*, but they may readily be separated by the following features: (i) the arms taper less in *S. tuberculiferus*; (ii) the arrangement of the plates in the centre of the disk is different in the two species; (iii) in *S. tuberculiferus* the abactinal granulation is uniform, and the largest supero-marginal plate granules are found in the centre of the plate, not at the edge as in *S. colubrinus*; (iv) *S. colubrinus* has infero-marginal tubercles only; *S. tuberculiferus* has tubercles on the abactinal plates and on both series of marginal plates.

Genus *Monachaster* Ludwig.

Monachaster umbonatus sp. n. (Pl. V, figs. 3 and 6.)

Occurrence:

St. A, Gulf of Suez, 65–68 m., soft yellow mud; 1 specimen.

Diagnosis.—Abactinal surface slightly raised, actinal surface flat. Arms scarcely tapering, rounded at the tip. Interbrachial arcs widely rounded. Abactinal plates covered with membrane bearing uniform granulation; some plates with flat round boss whose diameter is a little more than half that of plate on which it stands; other plates with low valvate pedicellariæ. Pores around all abactinal plates, absent only from inner side of plates on either side of interradial line. Supero-marginal plates tumid;

edges with small elongate granules, centre with mosaic of enormous polygonal granules. Infero-marginal plates with a similar granulation on lateral face ; on actinal face granules smaller and tending to imbricate. Actinal intermediate plates with granulation coarser than that of abactinal plates, granules tending to imbricate ; some plates with low valvate pedicellariæ. Adambulacral and mouth plates with actinal surface covered with granules finer than those of actinal plates ; furrow spines as in *Stellasteropsis*.

Description.—R 27 mm., r 12·5 mm., R/r 2·2. Four plates surround the anus and around these lie a ring of eight, of which five are radial and three interradial. In the other two interradii there is a single median plate lying just outside the ring. There are no other median interradial plates at all, and on either side of the interradial line lie four plates, all except the outermost the first of a row parallel with the carinals. There are nineteen carinal plates reaching the penultimate pair of supero-marginals. The plates are oval or hexagonal and a little longer than broad. On either side of them lie three rows containing respectively fourteen plates reaching the antipenultimate pair of supero-marginals, six plates reaching the third supero-marginal, and three plates reaching the proximal edge of the second supero-marginal.

The membrane is thick and the outlines of the plates are, in consequence, hard to make out. The granulation is uniform, but the centre of about ten of the carinals, five of the first laterals and two of the second laterals is occupied by a smooth low boss, the diameter of which is about half that of the plate on which it stands. Where these bosses are absent there is often a low valvate pedicellaria, flush with the granules surrounding it, near the centre of the plate. The pores occur everywhere except between the plates lying on either side of the interradial line. They are rather few around the central plates, about ten in number around the proximal radial plates, and about six in number around the distal radial plates.

There are nine tumid *supero-marginal plates*. A pair occupies the apex of each interbrachial arc. These two are broader than long. At the base of the ray the plates are square, but towards the tip of the ray they become broader than long again, as is shown by the following measurements :

	Plate No. 1.	3.	5.	7.
Height	1·75	1·5	1·25	1 mm.
Length	1·75–2·5	2·75	2·5	1·75 mm.
Breadth	3·5	2·75	2·5	2·5 „

The granulation of the plates is very characteristic. At the edge of each plate there are about four rows of closely crowded granules, narrower but longer than those of the abactinal area. In the next two or three rows the granules are larger, and then the greater portion of the centre of the plate is occupied by about five rows of vast polygonal plate-like granules fitting together in a close mozaic.

The *infero-marginal plates* correspond to the supero-marginals, but are not tumid. The lateral face bears very large polygonal granules like those of the supero-marginals, but on the actinal face the granules are not so large and they show a tendency to imbricate.

The *actinal intermediate areas* are paved with plates lying in three chevrons, of which the outermost encloses a few odd plates. Successive chevrons contain 12, 6 and 3 plates,

and the innermost extends to the fourth infero-marginal. The granulation is uniform, coarser than that of the abactinal surface, and the granules are very slightly overlapping. Low valvate pedicellariæ are found on many plates, particularly those of the innermost chevron.

The actinal face of the *adambulacral plates* is covered with granules a little finer than those of the actinal intermediate plates, and the pedicellariæ, where they occur, are also a little smaller. As in the genus *Stellasteropsis*, the furrow spines form a continuous palisade, roofing in the furrow.

Remarks.—Close to but not identical with this form is a specimen in the British Museum bearing the label: *Goniodiscus* sp. (yg), 63. 11. 19. 19. Mozambique. Dr. Livingstone.

Projecting from a hole about 5 mm. from the anus of this specimen is the tip of a Gasteropod shell.

Affinities.—The single row of spines on the adambulacral plates and the character of the granules on the supero-marginal plates place this specimen beyond doubt in the genus *Monachaster* Ludwig (1916, p. 412). It may be distinguished from the only other known species *M. sanderi* (Meissner) by the following characters: (i) *M. umbonatus* has slightly longer arms and more supero-marginal plates; (ii) the supero-marginal plates of *M. umbonatus* have no tubercles such as those of *M. sanderi*; (iii) the granulation of the abactinal plates of *M. umbonatus* is uniform: in *M. sanderi* larger granules are found round the pores.

Genus *Anthenoides* Perrier.

The distribution of the eight species belonging to this genus is as follows:

Ocean.	Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*piercei* Perrier	Perrier, 1884	3	1	West Indies	153 m.	..
		Verrill, 1915	Many		,, ,,	108–829 m.	Sand and shells; grey sand; hard ground.
Pacific	*epixanthus* Fisher	Fisher, 1906	..	..	Hawaii	333–486 m.	Various.
Eastern Archipelago	*granulosus* Fisher	,, 1913	6	3	Moluccas	480 m.	Grey mud; fine sand.
		Döderlein, 1924	2	2	Bali Sea	289–330 m.	Mud.
	lithosurus Fisher	Fisher, 1913, 1919	1	1	China Sea	380 m.	Grey mud and sand.
	rugulosus Fisher	,, ,, ,,	14	7	Philippines	375–700 m.	Green mud and ooze.
	cristatus (Sladen)	Sladen, 1889	..	1	,,	182 m.	Green mud.
		Fisher, 1919	88	14	,,	182 m.	Green mud; sand; rock; globigerina ooze.
Indian	*sarissa* (Alcock)	Alcock, 1893	..	..	Andaman Is.	230–456 m.	..
	marleyi Mortensen	Mortensen, 1925	1	1	Natal	..	..

A key to the known species is given by Fisher (1919, p. 329).

Anthenoides marleyi Mortensen.

Anthenoides marleyi, Mortensen, 1925, p. 149, pl. viii, figs. 1, 2, text-figs. 2, 3, 4.

Occurrence :

St. 106, Zanzibar Channel, 183–194 m., green mud ; 9 specimens.

Description.—The dimensions of the specimens are : R 70–108 mm., r 26–38 mm., R/r 2·6–2·8.

The *abactinal surface* is paved with flat polygonal plates, covered with granules, of which one, or occasionally two, or even three, are conspicuously enlarged.

The *supero-marginal plates*, which number twenty-two to twenty-five, are rounded and form a broad border to the abactinal surface. They are covered with granules, of which three or four are enlarged, one usually more than the rest. Two or three valvate pedicellariæ also occur on most of the supero-marginal plates. The *infero-marginal plates* correspond to the supero-marginals. On the lateral edge of the proximal plates are found four to six flattened truncate spinelets, which are 1–2 mm. long and are arranged in two rows or irregularly. This armature extends at least half-way down each arm. The actinal surface of the plates bears a number of small, well-spaced granules which decrease in size towards the inner border.

The *actinal intermediate plates* are covered with small granules. All the plates of the innermost chevron and a few of the others bear an elongate valvate pedicellaria. On the remaining plates one to five of the granules are enlarged.

The *adambulacral plates* bear six to eight furrow spines. On the proximal edge of the actinal surface of each plate stands an elongate valvate pedicellaria, and distal to it one, or more usually two, large flattened spines about 2·5 mm. long.

Colour.—Actinal surface, white ; abactinal surface, white with a fine reticulation of carnelian red between the plates. In spirit the specimens are yellowish.

Remarks.—There are two minor features in which the present specimens differ from the description of the type : (i) the type has two or three spinelets on the edge of the infero-marginal plates, while on the actinal surface stand " some irregular elevations, having the appearance of worn-off tubercle bases, which, however, they are evidently not " (Mortensen, *loc. cit.*). The lower row of infero-marginal spines on the present specimens do encroach on the actinal surface of the plate to some extent, but they resemble the spines of the upper row ; (ii) the type has generally but one actinal adambulacral spine co-existent with a single pedicellaria, whereas the present specimens have commonly two. In both these features the specimens recall the Philippine form, *A. cristatus* (Sladen), which is, however, easily distinguished by its round, papilliform pedicellariæ. Mortensen regards *A. marleyi* as being related to the Atlantic form *A. piercei* Perrier. It would stand next this form in Fisher's key (1919, p. 328). The differences are that *A. piercei* possesses no enlarged supero-marginal granules, and on the actinal face of its adambulacral plates there are no pedicellariæ, but three spines all shorter than the furrow spines.

Anthenoides cristatus (Sladen). (Pl. III, fig. 5, Pl. V, fig. 1.)

Leptogonaster cristatus, Sladen, 1889, p. 327, pl. liv, figs. 1–7.
Anthenoides cristatus, Fisher, 1919, p. 329, pl. 78, figs. 1, 2, pl. 88, fig. 1, pl. 89, fig. 1.

Occurrence :

St. 194, Gulf of Aden, 220 m., sand ? ; 495 specimens.

Distribution.—Philippines, 182 m. ; Gulf of Aden.

Remarks.—This large collection is singularly uniform in size, the range of major radial measurement being 27–60 mm., while the R/r ratio varies between 2·3 and 2·7. The major radius of over 90% of the total number of specimens falls between 30 and 40 mm., and only seventeen examples are larger than 50 mm. The dimensions of these specimens are :

R	.	60	59	59	58	57	56	54	53	53	52	52	51	51	50	50	50	50 mm.
r	.	25	26	26	22	25	25	25	23	23	20	21	23	22	23	22	21	21 ,,
R/r	.	2·4	2·3	2·3	2·6	2·3	2·3	2·2	2·3	2·3	2·6	2·5	2·2	2·3	2·2	2·3	2·4	2·4

The main description is taken from the smaller specimens with R 30–40 mm., as it is believed that this will be more valuable for subsequent comparison ; features characteristic of the larger series of specimens (R 50–60 mm.) are mentioned.

Description of Smaller Forms.—(i) *Arrangement of abactinal plates.*—The abactinal surface is covered with a thick membrane, and in order properly to investigate the arrangement of the plates it is necessary to boil the specimen in potash. For this reason a comparison of many specimens is not possible. Drying, however, reveals the plates more clearly, and from a number treated in this way, two (both have R 33 mm., r 14 mm.) which appeared to lie at either end of the range of variation were selected and boiled in potash. The first specimen has twenty-eight *carinal plates*, decreasing regularly in size from about the third plate to the tip of the ray. On the disk the plates are hexagonal with the edges rounded, and rather broader than long ; at the base of the arms they become more regular in shape, and the distal six or so, which lie between supero-marginals only, are longer than broad. They extend to the penultimate, or antipenultimate, pair of supero-marginals. On either side of each of the first nine carinals, separating them from the plates of the first lateral row, are two small secondary plates. A pore lies on either side of these plates, so that each carinal in this region is surrounded by six pores. The tenth to fifteenth carinals, being in direct contact with the plates of the first lateral row, are surrounded by only four pores. Beyond this level, the ninth supero-marginal plate, the pores cease.

The plates of the *first lateral* row are a little smaller than the carinals but resemble them in shape, in the regular decrease in size and in the elongation of the last few. Near the centre of the disk there are two or three secondary plates separating the first and second lateral rows, but most of the plates in these two rows are contiguous. Twenty plates reaching the tenth supero-marginal make up the first, thirteen similar but slightly smaller plates, reaching the sixth supero-marginal, make up the second lateral row and there are, besides, three rather irregular rows of plates. The initial plates of these five rows are a little larger than the rest and lie in pairs on either side of the interradial line, forming a distinct landmark, which is rendered more conspicuous by the fact that the adjacent faces of the plates are the only areas of the disk where papulæ are not found.

The second specimen has secondary plates on either side of the first fifteen carinals, and between the first six plates of the first and second lateral rows. A few secondary plates may also be seen between the plates of the other rows.

(ii) *External features.*—The following description is taken from all the smaller specimens. The *abactinal surface* is covered with a thick membrane. On each plate, lodged superficially in this membrane, there are a few scattered granules. About fifteen small ones lie near the periphery, while in the centre there are one or, on the larger plates, two, occasionally three, or even more granules, five to six times as large as the others. On a small number of specimens pedicellariæ are found. These are either of the elongate type figured by Sladen (1889, pl. liv, fig. 6), or of the truncate type described by Fisher (1919, p. 331). The *supero-marginal plates* number fifteen to seventeen. The abactinal surface of the first three or four plates slopes downwards slightly, that of the remaining plates lies horizontally, then sweeps round in a broad curve which flattens out to form a lateral face to the plate, set at an acute angle to the abactinal face so that in transverse section the arm is slightly concave. The height of all the plates is small, the first three are broader than long, the fourth square, and the remainder longer than broad. The granulation is like that of the abactinal plates. Approximately forty of the small granules lie in two indefinite rows near the periphery of the plate, and about half-a-dozen of the larger lie nearer the median line. On the sixth plate, or thereabouts, one of these comes to lie on the outer distal corner, where it projects as a conspicuous papilla visible on all the rest of the plates of the arm.

The *infero-marginal plates* correspond to the supero-marginals, and like them are all low. They form a massive rounded border to the intermediate areas, arching up well above the general level of the actinal surface. The breadth here is nearly twice the length, but it falls off rapidly along the arms and at the tip of the ray is less than the length. The lateral face of the first three to five plates bears two to five slightly pointed, round-tipped or truncate spines about 1 mm. long, while most of the plates of the arm bear a single spine which comes to lie on the outer distal corner, and diminishes rapidly in size on successive plates till it is no more than a granule.

The *actinal intermediate areas* extend to the fourth or fifth infero-marginal. The plates are diamond-shaped and overlapping. They fall into four clearly marked chevrons, the outermost enclosing a group of about three plates. The innermost chevron contains nine to twelve plates, the second to fourth chevrons about 7, 5 and 3 plates respectively. The granulation is similar to that of the abactinal and marginal plates, but the smaller granules, which are very widely spaced and number barely twenty on the largest plates, are found all over the surface of the plate and are not confined to the neighbourhood of the periphery. A single large granule stands near the centre of most plates. Two papilliform structures are seen on nearly every plate of the innermost chevron. One is usually a granule, the other a pedicellaria ; but the two are very hard to distinguish.

The *adambulacral plates* have a radiating series of four to six cylindrical or slightly flattened furrow spines, tapering at the extremity to a rounded tip and united by membrane at the base. The relative size is variable, for the two outermost may be of the same size as the rest, or so small as to be little more than granules. The remaining spines are usually subequal, but one or two in the centre may be longer than the rest. Close to the furrow spines, and near the proximal border of the plate, stands a two-jawed pedicellaria about half as long as the central furrow spine. Towards the distal border of the plate

and nearer the outer edge there is a single spine about as long as the pedicellaria but considerably more robust than a furrow spine. This spine becomes larger on successive plates, and on those which lie beyond the limits of the actinal intermediate plates it is longer than the furrow spines. In most specimens a certain number of the proximal plates bear a row of three smaller spines in place of the single one.

Description of Larger Specimens.—(i) *Arrangement of abactinal plates.*—Two specimens (R 51 and 58 mm.) were boiled. The smaller has thirty-six carinals, reaching the antipenultimate pair of supero-marginals, with a pair of secondary plates on either side of the first twelve ; and twenty-six first lateral plates, reaching the thirteenth supero-marginal, with a single secondary on the outer side of the first eight. There are seven more rows of plates between which a very occasional secondary is to be found. Papulæ are found all round the initial plates of the two outermost rows. This feature is not general, but is seen again in one or two of the other large specimens.

The second specimen shows exactly the same features, namely a well-developed adradial row of secondary plates, a poorly developed series between the first and second lateral rows of plates, and only an occasional one between the plates of the other rows.

(ii) *External features.*—The granulation of the *abactinal plates* is identical with that of the smaller specimens. Pedicellariæ occur on fourteen out of the seventeen specimens ; the largest number on one specimen is twenty-five. The *supero-marginal plates* number eighteen to twenty-two. In the interradius the *infero-marginals* project beyond the supero-marginals. Two to four spines are found on as many as the proximal ten infero-marginals. They attain a length of 2 mm.

There are five chevrons of *actinal intermediate plates*, the innermost containing fourteen to nineteen plates and reaching the seventh to ninth infero-marginal. As a rule each plate bears one large and about twenty small granules, but there may be more than one large granule and sometimes the granules are evenly graded in size.

The *adambulacral plates* bear four to six furrow spines. In all the larger specimens at least two or three plates have a row of three spines on the actinal surface, but in many of the specimens there are one or more ambulacra bordered by plates of which every one bears but a single actinal spine. The presence of one or three spines on the actinal surface of the adambulacral plates would seem to be a variable character and not a sound foundation on which to base a specific distinction.

Affinities.—This series of specimens differs from previous descriptions of *A. cristatus* (Sladen) in the following minor features : (i) the R/r ratio is slightly smaller ; (ii) the size is smaller ; of nearly five hundred specimens the largest has R 60 mm., whereas Fisher (1919, p. 329) records a specimen of R 110 mm. from a collection of eighty-eight ; (iii) large and small granules are found on nearly all the plates. The type is uniformly granulated.

In his key Fisher (1919, p. 328) separates *A. cristatus* from Alcock's Andaman species *A. sarissa* thus :

Proximally two or three subambulacral spines or prominent pedicellariæ, abactinal pedicellariæ *cristatus.*
Proximally one subambulacral spine, no abactinal pedicellariæ . . . . . *sarissa.*

The present series of specimens shows that the number of subambulacral spines is not a reliable character. Further, abactinal pedicellariæ were absent from three out of seventeen specimens with a major radius of more than 50 mm., and from the majority of

the smaller ones, and, as Alcock's specimen had R 44 mm., this character also must be discarded. Alcock, however, remarks that small plates are inlaid everywhere between the larger ones, and if this be so, it is too great a difference to be ignored and the two species must be regarded as distinct. The Indian Museum sent for comparison a specimen labelled "*Anthenoides sarissa*", but unfortunately it proved to be a young *Oreaster*.

Immature *Goniasteridæ*.

Occurrence :

St. 45, Arabian coast, 38 mm., Lithothamnion ; 4 specimens.

One (R 5 mm.) is perhaps an *Astroceramus*, two (R 5 and 4 mm.) are possibly *Anthenoides*. The fourth and largest (R 10 mm., r 7 mm.) is an interesting form which, as far as I can discover, is unlike any species previously known from the area. It has the following characters : The *abactinal plates* are circular, arranged in regular rows, and bordered with rather large hemispherical granules ; the centre of each plate is occupied by a single granule about twice the size of those round the edge. The *supero-marginal plates*, of which there are four, have a similar border but are naked centrally. The first two are oval, longer than broad, and lie at an angle to the abactinal surface. These are followed by what appears to be a rudimentary plate, and then comes a large tumid plate, twice the size of the first.

There are five *infero-marginal plates* showing a regular decrease in size from the interradius to the tip of the ray. Besides a border of granules similar to that of the supero-marginal plates, each one bears a tubercle on the outer distal corner, and these tubercles increase in size as the tip of the ray is approached. Plates are found between the marginals.

There are four chevrons of *actinal intermediate plates*, the innermost attaining the tip of the ray. Each plate is armed with two rows of three or four hemispherical granules, of which one in the centre of the plate is larger than the rest.

The *adambulacral plates* have four rather short round-tipped furrow spines and two rows of three or four granules on the actinal surface. One of the granules in the centre of each row is elongated, the elongation being more marked in the inner row.

The form of the granulation suggests that the example belongs to the genus *Hippasteria*, though the typical valvate pedicellariæ are absent and the enlarged last pair of supero-marginals is not usual in this genus.

Family Oreasteridæ.

Genus *Oreaster* Müller & Troschel.

Oreaster hiulcus Müller & Troschel.

Oreaster hiulcus, Müller & Troschel, 1842, p. 48.

Occurrence :

St. 53, Arabian coast, 13·5 m., rock, shingle, shells and Lithothamnion ; 2 specimens.

Distribution.—Indian Ocean.

Colour.—Abactinal tubercles, nopal red ; abactinal surface, a little darker than the tubercles ; actinal surface, white with a faint purplish tinge ; furrow spines, white ; infero-marginal spines, strawberry pink ; tube feet, orange cinnamon.

Oreaster sp. juv.

Occurrence :

St. 45. Arabian coast, 38 m., Lithothamnion ; 6 specimens.

Remarks.—The largest specimen measures R 11 mm., r 6 mm., the smallest R 7 mm., r 3·5 mm.

Family Linckiidæ.

Genus *Nardoa* Gray.

Nardoa faouzii sp. n. (Pl. I, figs. 8 and 9.)

Occurrence :

St. 53, Arabian coast, 13·5 m., rock, shingle, shells and Lithothamnion ; 1 specimen.

Diagnosis.—R/r 5·3. Disk small, scarcely elevated above the level of the arms ; with two rings of abactinal plates. Arms cylindrical, the actinal surface flattened ; distal third tapering to a blunt tip ; proximal quarter of ray with seven rows of almost flat abactinal plates in regular longitudinal and transverse series ; plates of carinal and first lateral rows rather irregular in arrangement on second quarter of ray, quite irregular beyond middle, where they are round but no smaller till quite near tip of ray ; plates of second lateral row reaching tip of ray in fairly regular line ; plates of third lateral row reaching middle of ray in regular line. Marginal and actinal plates in regular series throughout ray. All plates covered with close granulation, which, except on actinal plates, becomes finer towards the periphery of each plate. Papulæ in groups of six between abactinal plates, ten between marginals and seven between infero-marginal and actinal plates. Adambulacral armature in three series ; four or five furrow spines ; three large granuliform inner actinal spines and an outer row of four or five enlarged granules.

Description.—R 53 mm., r 10 mm. Two rings of plates surrounding a single central plate pave the abactinal surface of the *disk*. In the inner ring there are five large round radial plates, each about the size of the central plate, 3 mm. in diameter, and five small interradial plates less than 1 mm. in diameter. The outer ring also contains ten plates, five radials equal in breadth to the radials of the inner ring, but shorter owing to the fact that the distal edge is flattened, so that the plates are D-shaped ; and five interradials equal in size to the radial plates of the inner ring.

Co-serial with the radials is a line of quadrangular *carinal plates*, some 2 mm. broad by 1·5 mm. long. On either side of it lies a row of similar plates ; below this is a row of slightly smaller plates, and below this again a row of distinctly smaller plates, measuring about 1·5 by 1·25 mm. This regular arrangement is only found at the base of the ray and beyond is gradually lost. Thus of the carinal row the first four or five plates are arranged in a straight line, the next four or five are arranged less regularly, and beyond them, that is beyond a point about midway down the arm, the arrangement is quite irregular and the plates are round, without, however, showing any decrease in size till within about 5 mm. of the tip of the ray. Of the next, the first

lateral row, the first seven plates are in a straight line, the next eight in a rather irregular line, and the rest are arranged quite irregularly. The second lateral row extends in a more or less regular series to the tip of the ray, while the third, comprising some eighteen plates, extends in a regular line to the eleventh supero-marginal, where it disappears.

All the abactinal plates are only very slightly convex. Many have been rubbed bare, but those still undamaged show a close covering of hexagonal granules, which, near the periphery of the plate, are smaller and indistinguishable from those which cover the papular areas. Space is made for these by the rounding of the corners of the plates and in each one there are about six pores.

There are twenty-six *marginal plates* forming a distinct and regular series down the length of each arm. The first two supero-marginal plates are twice as high as broad, and the rest are square. The third plate measures 2 × 2 mm., and the remainder show a regular diminution in size to the tip of the ray. The granulation of the supero-marginals is similar to that of the abactinal plates. The infero-marginal plates lie directly below the supero-marginals and resemble them closely in size and granulation. Some ten pores occur in the areas between the marginal plates and seven in the areas between the infero-marginals and the actinal plates.

At the base of the ray there are three rows of *actinal plates*, the outermost of two, the middle of five, while the innermost extends to within 5 mm. of the tip of the ray. The plates, which decrease regularly in size, are broader than long, and the granulation becomes coarser towards the adambulacral border.

The *adambulacral plates* bear on a straight furrow margin four spines which are wedge-shaped in transverse section, and three times as long as broad; many bear also on the proximal side of these four a fifth smaller spine which is set back out of line with the rest. Outside the furrow series there is a row of three square truncate spines barely twice as long as broad. A third series of four or five is hardly to be distinguished from the granules of the actinal plates.

Affinities.—The regular arrangement of the first few abactinal plates is stated by Koehler (1910, p. 162) to be a feature of the young forms of *Nardoa lemonnieri*. *N. faouzii* is close to this species but may be distinguished at once by the abactinal plates, which are of much the same size almost to the tip of the ray. In *N. lemmonieri* they become small and elongated on the distal half of the ray. Two other closely related forms, *N. novæ-caledoniæ* Perrier and *N. mollis* Lütken, may be distinguished by the characters of the abactinal plates.

I have much pleasure in naming this species after Dr. Hussein Faouzi, Director of the Egyptian Fisheries Research Laboratory, and my colleague on the expedition.

Genus *Narcissia* Gray.

Narcissia mohamedi sp. n. (Pl. I, figs. 2 and 10.)

Occurrence:

St. 24, Gulf of Aden, 73–200 m., coarse sand, shell, ? rock; 1 specimen.

St. 157, Maldives, 229 m., coral rock; 1 specimen.

Diagnosis.—R/r 6·8. Disk large, paved with two rings of abactinal plates. Arms long; proximally with abactinal and actinal surfaces flattened; cross section about half, way down, round; tapering from a broad base to a fine pointed tip; abactinal surface

with three regular rows of plates ; lateral surface occupied by small plates in five irregular rows which rapidly become fewer distally. Supero-marginal plates rectangular ; in regular series bounding actinal border of lateral surface of arm. Infero-marginal plates similar ; confined to actinal surface. Actinal plates in four rows ; the three outermost short, innermost extending nearly to tip of ray. Adambulacral plates with five furrow spines, and on actinal surface an inner row of five short spines and an outer row of five granules. Whole surface with uniform miliary granulation. Papulæ in groups of four or five, only between abactinal and lateral plates.

Description.—The dimensions of the two specimens are R 95 mm., r 14 mm., and R 39 mm., r 6 mm. The arms are broad at the base, and a transverse section shows that the actinal surface is quite flat, and that the abactinal surface is also flattened to some extent. They taper rapidly, and distal to a point near the middle they are quite round in transverse section.

The centre of the *disk* is occupied by a hexagonal plate, 4 mm. in diameter, with the anus and two small plates lying to one side of it. Around this group of plates lies a ring consisting of five radials and five interradials, the radials a little smaller than the central plate, the interradials a little smaller than the radials. Outside this ring there are five radial plates similar to those of the inner ring and five groups of interradial plates. The arrangement of the plates in these groups is variable, but typically there is a larger plate on the interradial line with two smaller ones on either side.

From the radials of the disk to the tip of the ray runs a straight line of *carinal plates*, those at the base some 1·75 mm. long and 2 mm. broad, the rest showing a uniform diminution in size. On either side is a row of similar but narrower plates. This row sweeps round the interradial angle on the abactinal surface of the disk in a continuous band, isolating the groups of interradial plates mentioned above in a small triangular area. A small madreporite, about 1·5 mm. in diameter lies at the apex of one of these bands.

Forming the sides of the ray and disk but encroaching a little on to the abactinal surface, especially of the disk, is an area occupied by irregularly hexagonal plates about 1 mm. in diameter and arranged in five ill-marked series, which decrease rapidly in number so that half-way down the ray there are only two, and 4 mm. from the tip of the ray the single persisting row disappears.

The *supero-marginal plates* form a regular series bounding the actinal edge of the lateral surface of the ray. The plates are rectangular, those at the base of the ray 2 mm. long by 1·75 mm. broad, the rest decreasing progressively in size to the tip of the ray. The *infero-marginal plates* lie on the actinal surface and resemble the supero-marginals in size and shape.

Four rows of *actinal plates* are found at the base of the ray. The outermost contains four plates, reaching the second infero-marginal ; the next contains ten, reaching the fifth ; the next contains twenty, reaching the tenth infero-marginal, while the innermost row extends to within a few millimetres of the tip of the ray.

The entire surface of the animal is covered by a fine uniform miliary granulation, interrupted only by sulci which run transversely between the actinal and marginal plates, and, of course, the *pores*. Four or five of these are found at the corners of the abactinal and lateral plates, but they do not occur below the level of the supero-marginals. Between the carinal and first lateral rows of plates the pore-fields are nearly confluent.

The *adambulacral plates* bear on the furrow margin, which is slightly convex and also, owing to the fact that the inner half of each plate slopes down towards the furrow, sunk below the level of the rest of the plate, five flattened truncate spines, about 1 mm. long and 0·2 mm. broad. Actinally there is a row of five subquadrate truncate spines about half the length of the furrow spines, though in surface view they appear equal in height owing to the slope of the plate. Outside them stands a row of five angular granules.

The description is taken from a fine specimen from the Gulf of Aden, entire except for one arm, which is in process of regeneration. A smaller specimen from the Maldives, having R 39 mm., is almost certainly the same species. It differs in having only two or three pores per field, with the fields well separated, and at the base of the ray there are only three rows of lateral plates.

Affinities.—The tapering rays, the papulæ confined to the abactinal surface and the adambulacral armature are all features which characterize the genus *Narcissia*. On the other hand the present species lacks the carinate, triangular rays, which are found in the other members of the genus.

This species is named after Abdul Fateh Mohamed Effendi, of Cairo University, a member of the chemical staff of the expedition.

Genus *Ophidiaster* Agassiz.

Ophidiaster purpureus Perrier.

Ophidiaster purpureus, Perrier, 1869, p. 61.

Occurrence :

St. 157, Maldives, 229 m., coral rock ; 1 specimen.

Distribution.—New Ireland, Moluccas, Amboina, Maldives, Seychelles, Mauritius, Zanzibar.

Genus *Linckia* Nardo.

Linckia multifora (Lamarck).

Asterias multifora, Lamarck, 1816, p. 565.
Linckia multifora, Lütken, 1871, p. 276.

Occurrence :

St. M.B. 1 (*b*), Red Sea, 29 m., sand, shell and coral ; 1 specimen.
St. M.B. 1 (*d*), ,, ,, 26 m., ,, ,, 2 specimens.

Distribution.—Widely distributed in Indo-Pacific region.

Order SPINULOSA.

Family Asterinidæ.

Genus *Paranepanthia* Fisher.

Paranepanthia brachiata (Koehler).

Nepanthia brachiata, Koehler, 1910, p. 133, pl. xix, figs. 14 and 15.
Paranepanthia brachiata, Fisher, 1919, p. 420.

Occurrence :

St. 24, Gulf of Aden, 73–200 m., coarse sand and shell ; 1 specimen.
St. 43, Arabian Coast, 83–100 m. ; 4 specimens.
St. 45, ,, ,, 38 m., Lithothamnion ; 3 specimens.
St. 70, Gulf of Oman, 196 m., green mud ; 1 specimen.

Distribution.—Andaman Sea ; Gulf of Aden, Arabian Sea, Gulf of Oman.

Remarks.—The five specimens from Sts. 43 and 70 have been compared with Koehler's type from the Andaman Sea. All are smaller, having a major radius of about 25 mm., but otherwise they closely resemble the type. The four specimens from Sts. 24 and 45 probably belong to this species but they are all minute and certain identification is not possible.

Family Echinasteridæ.

Genus *Henricia* Gray.

Henricia sp.

Occurrence :

St. 24, Gulf of Aden, 73–200 m., coarse sand and shell ; 5 specimens.

Remarks.—The largest specimen of the five has R 43 mm., r 7 mm., the smallest R 36 mm., r 6 mm. The arms are round abactinally, flat actinally, and taper very gradually to a rounded tip.

The *abactinal plates* are small and the pits enclosed by them large, nearly 1 mm. in diameter. Small square plates occur in the pits and may stand between two pores, though it is usual to find only a single pore at the bottom of each pit. The plates are beset with two or three rows of spinelets, which are very fine, pointed, and invisible to the naked eye. There are about twenty on each plate.

Two rows of *marginal plates* can be traced to the tip of the ray. The *supero-marginal plates* are oval, broader than long, and some show two divergent articulating processes at the distal end. The *infero-marginal plates* correspond to the supero-marginals and are rectangular, twice as broad as long. The marginal plates are beset with about four rows of spinelets similar to those of the abactinal plates. Pores are not found between or below the marginals.

There is an inner row of *actinal plates* which correspond exactly with the infero-marginals. At the base of the ray the plates are twice as broad as long, but they become square, and about half-way down the ray the series comes to an end, the

last few plates being twice as long as broad. An outer row of plates extends for about 5 mm. The furrow margin of the *adambulacral plates* is angular. A single spine occupies the apex, while two similar spines stand on either side. Outside stands another row of three spines of the same size. The rest of the actinal surface of the plate is covered with three or four more rows of spines, which decrease in size till they are uniform with those of the rest of the body. Within the furrow the apex of the plate bears three fine upcurved spines.

Fisher issues several warnings about the difficulty of identifying the species of this genus, even with material for comparison. None exists from the locality whence these examples come, and, since all are young, the application of a specific name might, perhaps, lead only to subsequent confusion ; but I would suggest that they are near to the sub-antarctic form *H. præstans* (Sladen).

Henricia sp.

Occurrence :

St. 105, Zanzibar area, 238–293 m., green mud ; 5 specimens.

Remarks.—The largest has R 30 mm., r 4 mm. ; the smallest R 20 mm., r 3 mm. The rays are more pointed than those of the specimens described above, the abactinal plates larger relative to the papular pits, and the spinelets on the plates a little coarser. The marginal and adambulacral plates are similar to those of the specimens described above, but pores occur both between the marginals and between the infero-marginals and the actinal plates.

Genus *Dictyaster* Alcock & Wood-Mason.

Dictyaster sp.

Occurrence :

St. 54, Arabian coast, 1046 m., green mud ; 1 specimen.

Remarks.—A single small specimen (R 19 mm., r 9 mm.) belongs perhaps to this genus. Compared with the description of *D. xenophilus* Alcock (1893), the arms are shorter and broader at the base. Further, the specimen has but a single furrow spine on all the plates except the first, which has two, while in *D. xenophilus* there are three on the proximal and two on the remaining plates. Both these differences may be due to the difference in size.

Family Acanthasteridæ.

Genus *Acanthaster* Gervais.

Acanthaster ? mauritiensis de Loriol.

Acanthaster mauritiensis, de Loriol, 1885, p. 6, pl. xii, figs. 1–3.

Occurrence :

St. 53, Arabian coast, 13·5 m., rock, shells, shingle and Lithothamnion ; 1 specimen.

Distribution.—Indian Ocean.

Description.—R 74 mm., r 35 mm., arms 14, madreporites 10. The abactinal surface of the disk is covered with short, bluntly pointed spines, 2 to 4 mm. in length, each with at least half the shaft covered by a granular investment. On the arms the spines, which are set on irregular ridges, are more robust, up to 5 mm. in length. There is a series of rather blunt marginal spines, 4 to 5 mm. in length. Above it there is a ridge whereon the spines are irregular in size and distribution, though not in alignment. Below the marginal series there are three rows of spines, each 2 to 3 mm. long, with granules only about the base. The innermost of these three is the subambulacral series. There are four or five furrow spines, the inner two or three usually twice as long as the two outermost.

Colour.—Actinal surface and tube feet, pale olive buff; abactinal surface, pale purplish grey becoming purplish grey towards the tips of the arms; spines, nopal red, those of the actinal surface a little lighter. These colours are little changed in the preserved specimen.

Remarks.—This example is too young for a specific name to be applied with certainty, though it is probably *A. mauritiensis*. De Loriol had a number of specimens at his disposal, and mentions that among the smaller ones, one of 150 mm. diameter had the longest spines 7 mm. long, while most measured between 4 and 5 mm. These figures are a little larger than those of the present specimen, but the discrepancy does not seem great enough to be significant. *A. planci* (Linnæus) (including *echinites*), *A. ellisii* Gray and *A. solaris* Gray have spines longer than those of *A. mauritiensis*, while *A. brevispinus* Fisher has them shorter.

Family Pterasteridæ.

Genus *Pteraster* Müller & Troschel.

Pteraster obesus Clark.

Pteraster obesus, H. L. Clark, 1908, p. 282.

Occurrence:

St. 157, Maldives, 229 m., coral rock; 3 specimens.

St. 177, Gulf of Aden, 274–366 m., green mud and rock; 1 specimen.

Distribution.—Sagami Bay, Japan, 140 m.; Maldives, Gulf of Aden.

Genus *Retaster* Perrier.

Retaster sp.

Occurrence:

St. 27, Gulf of Aden, 37–91 m., sand and shells; 1 specimen.

Description.—R 15 mm., r 6 mm., R/r 2·5. The arms are round and taper gradually to a blunt upturned tip.

The plates of the abactinal surface have a four-rayed base, a vertical column and, surmounting this, four radiating hyaline spines supporting a delicate transparent membrane traversed by opaque white muscle bands. These are regularly arranged; four main

bands radiate from each column and there are often several subsidiary smaller ones as well. In each of the triangular areas, bounded by these bands, some half-dozen pores occur.

There are three adambulacral spines in a transverse series. The spines are hyaline, and are connected with each other and with the actino-lateral spine, which is four to five times as long, by a membrane extending almost to the tip of each spine. The actino-lateral spines are also joined by a longitudinal membrane, which, when lying flat, covers nearly the entire actinal surface of the animal.

The mouth plates bear a furrow series of five membrane-invested spines, which decrease in size progressively from the first. Actinally each plate bears a tapering hyaline spine as long as, but stouter than, the actino-lateral spines.

The specimen lies near *Retaster insignis* Sladen, a species well known from the Eastern Archipelago, but it is too small for definite identification.

Genus *Hymenaster* Wyville Thompson.

Hymenaster alcocki Koehler.

Hymenaster alcocki, Koehler, 1909, p. 110, pl. i, figs. 7, 8, pl. iii, fig. 8.

Occurrence :

St. 118, Zanzibar area, 1789 m., globigerina ooze ; 1 specimen.

Distribution.—Andaman Sea, 1175 m., 1 example ; Zanzibar.

Remarks.—The single specimen is small and in poor condition.

Hymenaster sp.

Occurrence :

St. 120, Zanzibar area, 2926 m., brown mud over grey globigerina ooze ; 2 specimens.

Remarks.—The specimens are too small to be referred to their proper species.

Order FORCIPULATA.

Family Zoroasteridæ.

Genus *Zoroaster* Wyville Thompson.

Zoroaster, Wyville Thompson, 1873, p. 154 ; H. L. Clark, 1920, p. 100 (distribution and key to known species) ; Fisher, 1919, p. 472 (key to Into-Pacific species).

Members of this genus abound in the Indian Ocean, and five species have been described by Alcock (1893, p. 108 *et seq.*) and one by Koehler (1909, p. 108). The expedition did not secure a large number of specimens, but those which were taken are in good condition. For the most part they closely agree with Alcock's descriptions and call for little comment.

Zoroaster alfredi Alcock.

Zoroaster alfredi, Alcock, 1893, p. 102.

Occurrence :

St. 81, Ras al Hadd, Arabia, 3351 m., grey clay ; 1 specimen.

Distribution.—Bay of Bengal, 2376–2522 m., globigerina ooze ; Arabian Sea.

Remarks.—Alcock describes this species as having the largest pedicellariæ—"as large as grape stones". The largest pedicellariæ of the present specimen, though of considerable size, are little over 2 mm. in length ; and a further difference lies in the presence of as many as five papulæ between the upper series of plates, whereas the type has three.

The colour of this specimen was not matched with colour standards, but was noted as " dirty white ".

Zoroaster angulatus Alcock.

Zoroaster angulatus, Alcock, 1893, p. 105.

Occurrence :

St. 159, Maldives, 914–1463 m. ; 2 specimens.

Distribution.—Gulf of Manaar, 1074 m., green mud, Laccadive Sea, 1269 m., coarse coral shingle ; Maldives.

Remarks.—The dimensions of both specimens are : R 165 mm., r 12 mm., R/r 13·75.

Zoroaster sp. juv.

Occurrence :

St. 168, Central part of the Arabian Sea, 2937–3182 m., rock ; 1 specimen.

Remarks.—This, a four-rayed specimen, has the following dimensions : R 60 mm., r 6 mm., R/r 10.

Colour.—Actinal surface, salmon orange ; tube feet, dull indian purple ; abactinal surface, salmon orange with the disk and a broad irregular line down the arms, white.

Genus *Cnemidaster* Sladen.

Cnemidaster squameus (Alcock).

Zoroaster squameus, Alcock, 1893, p. 109.
Cnemidaster squameus, Fisher, 1919, p. 481.

Occurrence :

St. 185, Gulf of Aden, 2000 m., green mud ; 2 specimens.

Distribution.—Laccadive Sea, 1906 m., green mud ; Gulf of Aden.

Family Asteriidæ.

Genus *Sclerasterias* Perrier.

A revision together with an account of the distribution of this genus is given by Fisher, 1928, p. 107.

Sclerasterias mazophorus (Alcock & Wood-Mason). (Text-fig. 12.)

Asterias mazophorus, Alcock & Wood-Mason, 1891, p. 436 ; Alcock, 1893, p. 115.
Sclerasterias mazophorus, Fisher, 1928, p. 107.

Occurrence :

St. 35, Gulf of Aden, 457–549 m., green mud, sand and shell ; 1 specimen.

St. 194, Gulf of Aden, 220 m. ; 18 specimens.

Distribution.—Bay of Bengal; Gulf of Aden.

Description.—The individuals are very uniform both in characters and size. The following description is taken from one of the best preserved specimens. R 50 mm., r 5 mm., R/r 10, greatest breadth of arm 8 mm. The arms are constricted at the base, broadest about a quarter of the way down, and from this point they taper to a rounded tip. They are rather flat, the height of an arm lying on its actinal surface being some 4 mm.

The *abactinal skeleton*.—The carinal plates (Text-fig. 12a) extend down the ray as a regular series of cruciform ossicles, of which approximately two in every three bear a pointed upright spine, some 2 mm. long and encircled about the base by a wreath of pedicellariæ. Between the carinals and the supero-marginals lie two ossicles (Text-fig. 12b and c), of which one or the other bears a radially directed articulating process which is very occasionally found to bear a spine. The two outer series of plates, the *marginals*, (Text-fig. 12d and e) lie at a steep angle and form the sides of the ray. The plates are roughly cruciform, with one arm, the external in the case of the supero-marginals and the internal in the case of the infero-marginals, longer than the others. Approximately every second supero-marginal plate bears a spine, similar to the spines of the carinals. Every infero-marginal plate bears two spines, the larger somewhat longer than the spines of the other plates and armed with pedicellariæ only on its abactinal surface, the smaller situated outside and below the larger, about half the size and unarmed. A web of membrane, particularly conspicuous near the base, runs along the side of the ray and unites the infero-marginal spines.

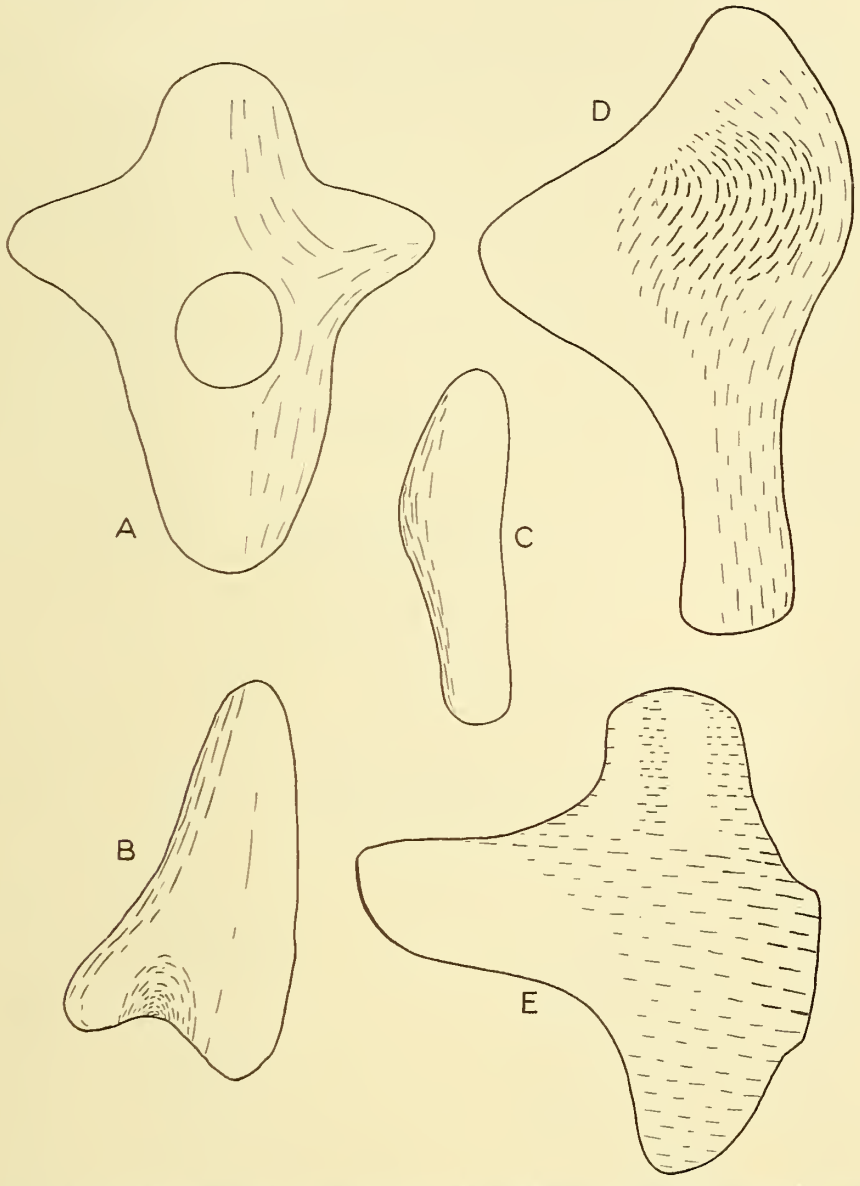
The *papulæ* lie in four rows, emerging in groups of four or five between the carinal, adradial, supero-marginal and infero-marginal plates, and singly between the infero-marginal and actinal plates.

The *furrow spines* are fine, straight-sided, truncate at the tip and articulated by a broadened base. There are two spines to a plate, the bases overlap and the proximal stands outside the distal spine.

Each *mouth plate* bears at the inner angle a round truncate incurved tooth, a trifle shorter but more robust than the adambulacral spines. Springing from near the base of this tooth is a shorter pointed spine, directed into the furrow. A large pedicellaria is

often associated with this spine. The abactinal surface of the plate bears a large round truncate spine, about equal in length to an adambulacral spine but stouter.

The abactinal membrane of the preserved specimens is of a reddish-brown *colour*. The actinal surface is white.



Text-fig. 12.—*Sclerasterias mazophorus* (Alcock & Wood-Mason). (St. 194.) A, Carinal ossicle; B and C, Adradial ossicles; D, Supero-marginal ossicle; E, Infero-marginal ossicle.

Affinities.—Three species, *Coscinasterias* (*Distolasterias*) *euplecta* (Fisher, 1906), from Hawaii, *Distolasterias hypacantha* (Fisher, 1907) from the Philippines, and *Eustolasterias stenactis* (H. L. Clark, 1925) from Natal are mentioned by Fisher (1928, p. 107) as "closely related and apparently small species or forms of a wide-ranging species". He suggests that all may ultimately prove to be races of *S. mazophorus*, *if* Alcock proves to be wrong in stating that spines occur on all the carinal and supero-marginal plates.

It is very unfortunate that, although I have had the opportunity to examine a specimen of *mazophorus* from the Indian Museum, I am not in a position to settle this point, as so many spines have obviously dropped off. A number of plates, however, lack any trace of a scar and give the impression that they have never borne a spine. Furthermore, the present specimens, which certainly do not bear spines on every carinal plate, agree closely with the example of *mazophorus* (not the type) from the Indian Museum. In fact the agreement is closer than the original description. This description seems to me to suggest that the infero-marginal spines bear a complete wreath of pedicellariæ, which is not the case, and the skeleton of the specimen sent was not as Alcock described it. The adradial series is composed of two distinct plates, one of which bears an articulating process directed longitudinally, and the infero-marginal plates have a long articulating process passing upwards and inside the articulating process of the supero-marginal. The skeleton is in fact identical with the specimens which are figured here.

It would seem therefore that the specimens collected by the expedition belong to the species *Sclerasterias mazophorus* (Alcock & Wood-Mason), and that, when it is possible to compare them with collections of *Sclerasterias euplecta*, *S. euplecta hypacantha* and *S. euplecta stenactis*, all will be found to be local races of a single widespread species, as is suggested by Fisher.

Family Brisingidæ.

Genus *Odinia* Perrier.

The genus is distributed as follows :

Ocean.	Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*semicoronata* (Perrier)	Perrier, 1885	2	1	Coast of Africa (equatorial)	1056–1435 m.	Rock.
		Mortensen, 1913	..	..	Off Greenland	..	..
	americana (Verrill)	Verrill, 1880, 1885	1	1	Off Nova Scotia	320 m.	..
	robusta (Perrier)	Perrier, 1885	2	2	Coast of Africa (equatorial)	882–1435 m.	Rock.
		Koehler, 1895	..	1	Coast of France	1750 m.	..
		,, 1909*a*	1	1	Canary Is.	2165 m.	Globigerina ooze.
	elegans (Perrier)	Perrier, 1885	15	2	Coast of Africa (equatorial)	882–1435 m.	Rock.
	pandina Sladen	Sladen, 1889	..	1	Faero channel	800 m.	..
	antillensis A. H. Clark	Clark, 1934	2	1	West Indies	504–595 m.	..
Pacific	*pacificus* Fisher	Fisher, 1906	2	2	Hawaiian Is.	500–950 m.	Broken shells and gravel; fine grey sand and mud.
Eastern Archipelago	*penichra* Fisher	Fisher, 1916, 1919	1	1	Philippines	200 m.	Coarse grey sand.
	magister Fisher	,, 1917, 1919	1	1	,,	..	..
Indian	*clarki* Koehler	Koehler, 1909	4	1	Maldives	837 m.	..
	austini Koehler	,, ,,	1	1	Off Ceylon	733 m.	..

Odinia austini Koehler.

Odinia austini, Koehler, 1909, p. 124, pl. iv, fig. 7*; pl. xiii, figs. 5, 6.

Occurrence:

St. 152. Maldives, 609–915 m., green sand; 1 specimen.

Distribution.—Ceylon: Maldives.

Remarks.—Koehler separates *O. austini* from *O. clarki* on the grounds that the former lacks furrow spines, actinal oral spines and pedicellariæ on the mouth spines. The present specimen has a disk diameter of 27 mm. and is larger than Koehler's example of *O. austini*. It lacks furrow and actinal oral spines, and therefore I have applied this name to it, but the spines on the border of the mouth plates are armed with pedicellariæ and it is thus to some extent intermediate between the two species. I feel, however, that more material is required before these two can be regarded as identical.

Colour.—Uniform coral red with furrows and actinal rim of the disk lighter. In spirit the specimen is white.

Genus *Brisinga* Asbjørnsen.

In 1917 Fisher (see also Fisher, 1919, 1928) revised the family *Brisingidæ*, and many species previously referred to the genus *Brisinga* were placed by him in newly erected genera. The distribution of the genus in the restricted sense is shown in the table below:

Ocean.	Species.	Reference.	Number caught.	Number of stations.	Locality.	Depth.	Bottom.
Atlantic	*endacacnemos* Asbjørnsen	Many records. (Asbjørnsen, 1856; Dujardin et Hupé, 1862; Sladen, 1889; Brunchorst, 1891; Bell, 1892; Norman, 1893; Perrier, 1894; Apellöf, 1896; Nicols, 1903; Koehler, 1909*a*; Farran, 1913.)					
	costata Verrill	Verrill, 1885	..	..	American coast	1623–3693 m.	..
	hirsuta Perrier	Perrier, 1894	1	1	Off Norway	2030 m.	
Pacific	*tenella* Ludwig	Ludwig, 1905	10	1	Galapagos Is.	2418 m.	Globigerina ooze.
	panamensis Ludwig	,, ,,	28	6	Gulf of Panama, Gulf of California, Galapagos Is.	1820–2418 m.	Green mud; sand; rocks; globigerina ooze.
		Clark, 1913	6	3	Off California	1586–1911 m.	..
	exilis Fisher	Fisher, 1904	..	1	,,	1133 m.	Green mud; rocks.
Eastern Archipelago	*trachydisca* Fisher	,, 1916	12	6	Philippines	1100–1400 m.	Green mud; sand; coral.
Indian	*insularum* Alcock & Wood-Mason	Alcock and Wood-Mason, 1891	..	..	Laccadive Sea	1900 m.	Green mud and foraminifera.
	bengalensis Alcock & Wood-Mason	Ditto	..	..	Bay of Bengal	1000 m.	Grey mud.
	andamanica Alcock & Wood-Mason	,,	..	..	Andaman Sea	750 m.	Green mud.
	gunnii Alcock	Alcock, 1893	..	..	Konkan coast	1020 m.	Green sand.

* In his text Koehler gives this figure as one of the illustrations of *O. austini*, but on the plate it is labelled *O. clarki*.

Brisinga trachydisca Fisher.

Brisinga trachydisca, Fisher, 1916, p. 31 ; 1919, p. 510, pl. 145, pl. 149, fig. 5, pl. 152, figs. 1 *a–c*, pl. 156, figs. 1, 1*a*.

Occurrence :

St. 108, Zanzibar area, 786 m., grey mud ; 3 disks and arms.
St. 115, ,, ,, 640–658 m. ; 6 disks and arms.
St. 124, ,, ,, 914 m. ; arms only.

Distribution.—Philippines, 1100–1400 m. ; Zanzibar area.

Remarks.—Of the nine disks, four have thirteen and five fourteen arms. Fisher gives the number of arms as twelve or thirteen. In other respects the specimens agree with Fisher's description.

Brisinga gunnii Alcock.

Brisinga gunnii, Alcock, 1893, p. 120.

Occurrence :

St. 34, Gulf of Aden, 1022 m., green mud ; arms only.

Distribution.—Konkan coast, India, 1020 m. ; Gulf of Aden.

Remarks.—The arms are similar to those taken in the neighbourhood of Zanzibar, but the costæ are fewer (about thirty) and they tend to form " hoops " at the side of the ray. Both these features are characteristic of *B. gunnii* which is closely related to *B. trachydisca*.

Genus *Freyellaster* Fisher.

Freyellaster spatulifer Fisher.

Freyellaster spatulifer, Fisher, 1916, p. 34 ; 1918, p. 104 ; 1919, p. 538, pl. 144, fig. 1, pl. 154, fig. 3, pl. 155, figs. 1, 1*a–h*.

Occurrence :

St. 118, Zanzibar area, 1789 m., globigerina ooze ; 2 specimens.

Distribution.—Celebes ; Zanzibar area.

RELATIONSHIPS OF THE FAUNA OF THE WESTERN INDIAN OCEAN

A chart showing the track of H.E.M.S. " Mabahiss " is given at the end of Vol. I No. 1, and the stations where Asteroids were taken are listed below. Investigations in the Bay of Bengal and the Arabian Sea have been carried out in past years by the R.I.M.S. " Investigator ". H.M.S. " Sealark " had dredged around the Maldives and Seychelles, and the passage of the " Valdivia " took her to Zanzibar and thence north along the African coast : unfortunately the report on the " Sealark " collections is too unsound to be considered, and that of the " Valdivia " has, at the time of writing, extended only to the family *Porcellanasteridæ*.

This discussion, therefore, is based on the present report and the reports on the " Investigator " material by Alcock (1893) and Koehler (1909). Koehler's list, emended by the removal of two new and one previously described species of *Nymphaster*, contains thirty-six species, of which twenty-eight are new. Alcock's list, emended by Koehler and further altered by the removal of *Dytaster anacanthus* Alcock & Wood-Mason, has forty-eight species, of which forty are new. The deep-water species obtained by the John Murray Expedition number forty, of which thirteen species and two sub-species are new, ten are due to Alcock or Koehler, and fifteen are due to other authors and are, therefore, new to the region. The total number of species known to occur in the Western Indian Ocean is thus one hundred and fourteen. With our present knowledge it is possible to compare not only the faunas of the different areas within the region of the Indian Ocean with each other. but also the fauna as a whole with that of the regions which adjoin. To the south, the region around the Cape of Good Hope has been thoroughly worked by the vessels of the Union of South Africa Fisheries and Marine Biological Survey, whose catches have been reported on by H. L. Clark (1923, 1925) and Mortensen (1933). The Antarctic Asteroidea are known from the researches of the " Scotia " and the " National Expedition Antarctique Française ". The Eastern Archipelago is a region whose starfish fauna has received more attention than that of most : the " Albatross " and " Siboga " have made large collections, and many of the earlier expeditions brought home material from this part of the world. Further east the Pacific fauna is little known until the American coast, where the " Albatross " has done much collecting, is reached, and the only substantial contribution to our knowledge of the Asteroids of the Mid-Pacific is derived from the visit of the " Albatross " to the Hawaiian Islands in 1903.

In order that comparison may be made the region covered by the " Investigator " and the " Mabahiss " is here divided into seven areas. To the first three arbitrary boundaries have been assigned :

i. *Bay of Bengal :*

In this area I have included the region to the East of the Andaman and Nicobar Islands that has been termed the Andaman Sea. This area is bounded by the parallel of 5° N.

ii. *Arabian Sea :*

This area, in which I include the Gulf of Oman, is separated from the Gulf of Aden area by a line joining Cape Gardafui and Ras Fartak, and is bounded to the south by a line between Cape Gardafui and the south-west corner of the Gulf of Manaar area (Stas. 43, 45, 53, 59, 70, 72).

iii. *Gulf of Manaar :*

The boundaries of this small intermediate area are the parallels 5° N. and 10° N. and the meridians 78° E. and 80° E.

The limits of the next three areas are defined only by the positions in which " Mabahiss " worked successful biological stations.

iv. *Maldive Archipelago :*

Stations were located only between the atolls and within an area extending a few miles on either side (Stas. 143, 145, 146, 152, 153, 157, 159).

v. *Zanzibar area :*

All successful biological stations were within a radius of twenty miles from the Island (Stas. 104 to 110, 115, 116, 118, 120, 122, 123, 124).

vi. *African coast :*

This area has but a single station (171) on the south-west slope of the Carlsberg ridge.

vii. *Gulf of Aden :*

This area is separated from the Red Sea by the Straits of Bab-el-Mandeb and from the Arabian Sea by a line joining Cape Gardafui and Ras Fartak (Stas. 22, 24, 26, 27, 34; 35, 184, 185, 194).

For each area I have given below a list of the known species. " Investigator " records have been taken from Koehler's paper (1909, pp. 129–137), in which he gives both an account of the species described or recorded by him and a revised list of those recorded by Alcock. Accompanying each species I give the following data :

(i) Other areas or regions from which it is recorded. When the record is not due to the author of the species, the recorder's name or an abbreviation is given in brackets. The following abbreviations are used : A. = Alcock, A. & W.M. = Alcock and Wood-Mason, J.M. = John Murray Expedition, K. = Koehler.

(ii) Closely related species, and—

(iii) The distribution of these closely related species.

Two species have not been considered to be closely related unless the author of one of the species has definitely mentioned such a relationship. The apparent affinities of a fauna assessed by this means must be regarded with caution, for the determination of what constitutes close relationship is open to great personal variation : Fisher, for instance, considers two species to be related more readily than either Alcock or Koehler, and as a result there is, perhaps, in the following lists an undue emphasis on relationship with species occurring in the Eastern Archipelago.

Bay of Bengal :

" Mabahiss " did not visit this area and all the records are from the reports of Alcock and Koehler. Most of the specimens listed by the latter occurred east of longitude 90°. Alcock does not give exact positions, but records his specimens either from the " Bay of Bengal " or the " Andaman Sea ". Most of the species occurring in depths of less than 2000 metres are from the latter area ; whereas, with but few exceptions, those from depths greater than 2000 metres are from the former.

0–500 metres. 0–273 fathoms.

Species.	Other localities.	Related species.	Localities.
Dipsacaster pentagonalis A.	..	..	..
Calliaster mammillifer A.	..	..	..
Fromia andamanensis K.	..	..	..
Palmipes pellucidus A. (= ? yg. *ludovicus* K.)	..	..	..
Dictyaster xenophilus A. & W.M.	..	..	..
Persephonaster cœlochiles A.	..	*P. curyactis* F.	Eastern Archipelago.
		P. misakiensis Goto	Japan.
Mediaster florifer (A.)	..	? *Rosaster cassidatus* sp. n.	Maldives.
Lithosoma pentaphylla (A.)	..	*L. actinometra* F.	Eastern Archipelago.
Anthenoides sarissa (A.)	..	*A. cristatus* (Sladen)	,, ,, Gulf of Aden (J.M.).
Zoroaster carinatus A.	..	*Z. c. philippensis* F.	Eastern Archipelago.
		Z. adami K.	Arabian Sea.
Ceramaster arcuatus (Sladen)	Japan	..	..
Miltcliphaster wood-masoni A.	Maldives (J.M.)	..	..
Dipsacaster sladeni A.	Cape of Good Hope (H. L. Clark)	..	..
Paranepanthia brachiata (K.)	Arabian Sea (J.M.), Gulf of Aden (J.M.)	*P. joubini* (K.)	Eastern Archipelago.
Sclerasterias mazophorus (A. & W.M.)	,, ,, ,,	*S. euplecta* (F.)	Hawaii.
		S. hypacantha (F.)	Eastern Archipelago.
		S. stenactis (H. L. Clark)	Natal.

500–1000 metres. 273–546 fathoms.

Species.	Other localities.	Related species.	Localities.
Zoroaster gilesii A.	..	..	..
Nymphaster nora A.	..	*N. mœbii* (Studer)	Eastern Archipelago.
Henricia mutans (K.)	..	*H. præstans* (Sladen)	Southern Ocean.
Brisinga andamanica A. & W.M.	..	*B. trachydisca* F.	Eastern Archipelago.
		B. insularum A. & W.M.	Arabian Sea.
Astropecten griegi K.	Arabian Sea, Maldives (J.M.)	..	..
Pseudarchaster mozaicus A. & W.M.	Arabian Sea (K.), Gulf of Manaar (K.), Zanzibar (J.M.)	*P. jordani* F.	Hawaii, Eastern Archipelago, Gulf of Manaar (K), Arabian Sea (K.).

1000–2000 metres. 546–1093 fathoms.

Brisinga gracilis K.	..	..	..
B. bengalensis A. & W.M.	..	*B. insularum* A. & W.M.	Arabian Sea.
Zoroaster adami K.	..	*Z. carinatus* A.	Bay of Bengal.
Eugoniaster investigatoris (A.)	..	*E. döderleini* (K.)	Arabian Sea.
		E. ephemeralis sp. n.	Zanzibar.
Pentagonaster mortenseni K.	..	*Ceramaster arcticus* Verrill	Bering Sea.
Psilaster agassizii (K.)	..	*P. gotoi* F.	Eastern Archipelago.
Nymphaster mœbii (Studer)	Eastern Archipelago all areas (see p. 374)	*N. euryplax* F.	Eastern Archipelago.
Sidonaster batheri K.	Arabian Sea, Gulf of Manaar	*S. vaneyi* F.	,, ,, Arabian Sea (K.).
H. alcocki K.	Zanzibar (J.M.)	..	..
Cheiraster snyderi F.	Hawaii	..	..

2000–3000 metres. 1093–1640 fathoms.

Freyella indica K.	..	..	..
Porcellanaster caulifer Sladen	Eastern Archipelago, Arabian Sea (K.), Gulf of Manaar (K.), Cape of Good Hope (H. L. Clark)	..	..
Zoroaster alfredi A.	Arabian Sea (J.M.)	*Z. ophiactis* F.	Eastern Archipelago.
Z. barathri A.	..	*Z. microporus* F.	,, ,,
Benthopecten huddlestonii (A.)	..	*B. moluccanus* F.	,, ,,

3000–4000 metres. 1640–2187 fathoms.

Caulaster dubius K.	..	..	..
Paragonaster tenuiradiis A.	..	..	..
Styracaster clavipes A. & W.M.	..	..	..
Hymenaster nobilis Wyville Thompson	S. Australia	*H. rhodopeplus* F.	Eastern Archipelago.
		H. koehleri F.	North Pacific.
Hyphalaster tara A. & W.M.	African coast (J.M.)	..	..

3000–4000 metres. 1640–2187 fathoms—*cont.*

Species.	Other localities.	Related species.	Localities.
Styracaster caroli Ludwig .	Zanzibar	..	..
S. armatus Sladen . . .	Eastern Archipelago	..	..
Pararchaster semisquamatus Sladen	Japan	..	..
Dytaster exilis Sladen . .	Pacific coast of South America	..	..
Persephonaster gracilis (Sladen)	Japan, Arabian Sea (J.M.), African coast (J.M.), Zanzibar (J.M.)	..	..
Marsipaster hirsutus Sladen .	South Pacific	..	..
Freyella benthophila Sladen .	,, ,,	..	..
F. tuberculata Sladen . .	Equatorial Atlantic	..	..

There are forty-nine species in the above list and of these no less than eleven are peculiar to the area, being as yet unknown from any other region, and, furthermore, they have no known close relative: the genus *Dictyaster*, with two species, one of them littoral, is confined to the area, and the genus *Milteliphaster*, with one species, is known besides only from the Maldives. Fifteen other species are also unknown outside the area but four of these have near relatives in other areas of the Indian Ocean, while the remaining eleven have near relatives in other oceans: of these latter no less than nine occur in the Eastern Archipelago, and one extends as far north as Japan and another is found in the Bering Sea, while one occurs in the Southern Ocean.

Of the remaining twenty-three species five are known from other areas of the Indian Ocean and have close relatives either in the Indian Ocean itself (one species) or in other oceans (five species), and a further five are without any close relative. Finally, thirteen species are known to occur in other oceans. Of these latter three are found in the Eastern Archipelago (one occurring also at the Cape of Good Hope), three are from as far north in the Pacific as Japan, one is from Hawaii, three from the South Pacific, one from South Australia, one from the Cape of Good Hope and one from the Equatorial region of the Atlantic Ocean. It is interesting to note that no less than eight of these thirteen species have been recorded only from the greatest depths of the Bay of Bengal.

The Arabian Sea:

The stations worked by "Mabahiss" extend up the coast of Arabia to the Gulf of Oman. The "Investigator" also dredged in the Gulf of Oman, but her main collections are from farther south in the Laccadive Sea.

The "Mabahiss" collections are small, as the east coast of Arabia is barren over large areas. The slopes are steep and rocky and a large patch south of Ras el Hadd smelt strongly of sulphuretted hydrogen. The following species were taken:

0–100 metres. 0–54 fathoms.

Astropecten monacanthus Sladen, *Stellaster equestris* (Retzius), *Stellasteropsis colubrinus* sp. n., *S. tuberculiferus* sp. n., *Oreaster hiulcus* Müller and Troschel, *Nardoa faouzii* sp. n., *Paranepanthia brachiata* (Koehler), *Acanthaster mauritiensis* de Loriol.

2000–3000 metres. 1093–1640 fathoms.

Species.	Other localities.	Related species.	Localities.
Pseudarchaster diversigranulatus sp. n.	Gulf of Aden	*P. mozaicus* A. & W.M. .	Arabian Sea (K.), Bay of Bengal, Gulf of Manaar (K.), Zanzibar (J.M.).

3000–4000 metres. 1640–2187 fathoms.

Zoroaster alfredi A. . .	Bay of Bengal	*Z. ophiactis* F. . .	Eastern Archipelago.
Persephonaster gracilis (Sladen)	Japan, Bay of Bengal (A.), African coast (J.M.), Zanzibar (J.M.)	..	..

The following species were collected by the " Investigator ":

500–1000 metres. 273–546 fathoms.

Astroceramus fisheri K. . .	..	..	..
Astropecten griegi K. . .	Bay of Bengal, Maldives (J.M.)	..	..
Mediaster ornatus F. . .	Hawaii, Eastern Archipelago, Maldives (J.M.)	..	..
Pseudarchaster mozaicus A. & W. M.	Bay of Bengal, Gulf of Manaar (K.), Zanzibar (J.M.).	*P. jordani* F. . .	Hawaii, Eastern Archipelago, Gulf of Manaar (K.).

1000–2000 metres. 546–1093 fathoms.

Johannaster superbus K. . .	..	..	..
Circeaster marcelli K. . .	..	..	..
C. magdalenæ K. . . .	..	..	..
Mediaster roseus (A.) . .	..	..	..
Pentagonaster cuenoti K. . .	Gulf of Manaar	..	..
Brisinga insularum A. & W.M.	..	*B. andamanica* A. & W.M.	Bay of Bengal.
Sidonaster batheri K. . .	Bay of Bengal, Gulf of Manaar	*S. vaneyi* K. . .	See below.
S. vaneyi K.	Eastern Archipelago (F.)	*S. batheri* K. . . .	See above.
Pectinaster hispidus (A. & W.M.)	Gulf of Manaar (K.)	*P. mimicus* (Sladen) .	Eastern Archipelago.
		P. filholi Perrier . .	Atlantic.
Pectinaster mimicus (Sladen) .	Eastern Archipelago	*P. hispidus* (A. & W.M.) .	Arabian Sea, Gulf of Manaar (K.).
		P. filholi Perrier . .	Atlantic.
Pseudarchaster mozaicus A. & W. M.	Bay of Bengal, Gulf of Manaar (K.), Zanzibar (J.M.)	*P. jordani* F. . . .	See below.
P. jordani F.	Hawaii, Eastern Archipelago, Gulf of Manaar (K.)	*P. mozaicus* A. & W.M. .	See above.
Cnemidaster squameus (A.) .	Gulf of Aden (J.M.)	*C. wyvilli* F. . . .	Eastern Archipelago.
Brisinga gunnii A. . .	Gulf of Aden (J.M.)	*B. trachydisca* F. . .	,, ,,
Pontaster pilosus A. . .	Gulf of Manaar	..	..
Persephonaster rhodopeplus A. & W.M.	,, ,,	..	..
Zoroaster angulatus A. . .	,, ,, Maldives (J.M.)	..	..

2000–3000 metres. 1093–1640 fathoms.

Species.	Other localities.	Related species.	Localities.
Thoracaster alberti K.	..	..	..
Zoroaster planus A.	..	..	..
Pontaster cribrellum A.	..	*P. subtuberculatus* Sladen.	South Pacific.
Benthopecten violaceus (A.)	..	*B. styracius* F.	Eastern Archipelago.
		B. polyctenius F.	,, ,,
Pentagonaster pulvinus Sladen	..	*P. mirabilis* Perrier	Atlantic.
		P. misakiensis Goto	Japan.
Eugoniaster döderleini (K.)	..	*E. investigatoris* (A.)	Bay of Bengal.
		E. ephemeralis sp. n.	Zanzibar.
Nymphaster mœbii (Studer)	Eastern Archipelago (all areas, see p. 374)	*N. curyplax* F.	Eastern Archipelago.
Cnemidaster zea (A.)	Gulf of Manaar	*C. wyvilli* F.	,, ,,
Porcellanaster caulifer Sladen	Eastern Archipelago Bay of Bengal (K.), Gulf of Manaar (K.), Cape of Good Hope (H. L. Clark)	..	..

Disregarding the records from depths of less than 100 m., there are thirty-two species in the list. Twelve are confined to the area ; two genera, *Johannaster* with one species and *Circeaster* with two, are not known from elsewhere.

Twenty species occur outside the Arabian Sea or have close relatives in other areas, and of sixteen of these, 50% of the total number of species, the distribution extends to, or relatives are found in, the Eastern Archipelago.

Of the species occurring in other areas of the Indian Ocean it is noteworthy that only seven, all widely distributed forms, have been recorded from the Bay of Bengal, while two others have a close relative in that area ; five species extend only to the Gulf of Manaar and three to the Gulf of Aden.

Three species have Atlantic relatives, but all have relatives in the Eastern Archipelago as well. One species has a South Pacific relative.

The characteristics of the fauna of the Arabian Sea and the Bay of Bengal may be summarized together :

(i) In both between a quarter and a third of the total number of species have not been found outside the area and are not closely related to any other known form. On the other hand, with few exceptions, these species belong to genera well known and widely distributed in other parts of the Indo-Pacific region.

(ii) The fauna of both shows a close affinity with that of the Eastern Archipelago.

(iii) The affinity of the two with this area is apparently closer than their affinity with each other.

(iv) In both a small number of species, nearly all occurring at the greatest depths, are known also from, or have relatives in, the South Pacific, the Southern or the Atlantic Ocean.

Gulf of Manaar:

Off the west coast of Ceylon there is a deep gulley, lined with blue clay—an unusual bottom deposit in the Indian Ocean. The "Investigator" has dredged a remarkable collection of species from this area, and it is, therefore, now treated separately:

Species.	Other localities.	Related species.	Localities.
	500–1000 metres. 273–546 fathoms.		
Lydiaster johannæ K.	..	..	..
Benthopecten indicus (K.)	..	..	..
Cheiraster inops F.	Hawaii, Eastern Archipelago	..	..
Evoplosoma augusti K.	..	*E. forcipifera* F.	Hawaii.
Odinia austini K.	Maldives (J.M.)	*O. clarki* K.	Maldives.
P. mozaicus A. & W.M.	Arabian Sea, Bay of Bengal, Zanzibar (J.M.)	*P. jordani* F.	See below.
	1000–2000 metres. 546–1093 fathoms.		
Zoroaster angulatus A.	Arabian Sea, Maldives (J.M.)	..	..
Pontaster pilosus A.	Arabian Sea	..	..
Pentagonaster cuenoti K.	Arabian Sea	..	..
Persephonaster rhodopeplus A. & W.M.	,, ,,	..	..
Pectinaster hispidus (A. & W.M.)	,, ,,	*P. mimicus* (Sladen)	Eastern Archipelago.
		P. filholi Perrier	Atlantic.
Sidonaster batheri K.	,, ,, Bay of Bengal	*S. vaneyi* K.	Arabian Sea. Eastern Archipelago (F.).
Pseudarchaster jordani F.	Hawaii, Eastern Archipelago, Arabian Sea (K.)	*P. mozaicus* A. & W.M.	See above.
Nymphaster mœbii (Studer)	Eastern Archipelago (all areas, see p. 374)	*N. euryplax* F.	Eastern Archipelago.
Cnemidaster zea (A.)	Arabian Sea	*C. wyvilli* F.	,, ,,
Hymenaster pentagonalis F.	Hawaii	..	..
Brisinga panopla F.	,,	*B. parallela* K.	Gulf of Manaar.
B. parallela K.	..	*B. panopla* F.	Hawaii.
Persephonaster croceus A.&W.M.	..	*P. monostœchus* F.	Eastern Archipelago.
Pentagonaster annandalei K.	..	*P. micropelta* F.	Hawaii.
	2000–3000 metres. 1093-1640 fathoms.		
Porcellanaster caulifer Sladen	Eastern Archipelago, Arabian Sea (K.), Bay of Bengal (K.), Cape of Good Hope (H. L. Clark)	..	..

Of the twenty-one species in this list, there are only two which neither occur nor have a relative elsewhere. One is the only known member of its genus (*Lydiaster*).

Four of the seven species common to the Bay of Bengal and the Arabian Sea are recorded in this area. Five species occur both here and in the Arabian Sea, but there are no species whose known distribution embraces this area and the Bay of Bengal only.

The main interest lies in the close affinity with the Hawaiian Islands. *Hymenaster pentagonalis* and *Brisinga panopla* are known only from these islands and the area under discussion; *Cheiraster inops* and *Pseudarchaster jordani* have a similar distribution but have been found in the Eastern Archipelago as well. Three species (*Brisinga parallela*, *Evoplosoma augusti* and *Pentagonaster annandalei*) are closely related to Hawaiian species, and *Pseudarchaster mozaicum* is very close to *P. jordani*, also from Hawaii.

The Maldive Archipelago :

This area was visited in 1906 by the Percy Sladen Trust Expedition, but many of the starfish collected have been inaccurately named, and the following list includes only those taken by " Mabahiss " :

Species.	Other localities.	Related species.	Localities.
	0–50 metres. 0–27 fathoms.		
Astropecten polyacanthus Müller & Troschel	Widely distributed	..	..
	50–500 metres. 27–273 fathoms.		
Dipsacaster farquharsoni sp. n.	..	..	..
Astroceramus cadessus sp. n.	..	..	..
Narcissia mohamedi sp. n.	Gulf of Aden	..	..
Astropecten griegi K.	Bay of Bengal, Arabian Sea	..	..
Milteliphaster wood-masoni A.	Bay of Bengal	..	..
Ophidiaster purpureus Perrier	Widely distributed	..	..
Rosaster cassidatus sp. n.	..	? *Mediaster florifer* (A.)	Bay of Bengal.
Astropecten pusillulus F.	Hawaii	*A. eremicus* F.	Eastern Archipelago.
Paragonaster ctenipes brevi-radiatus subsp. n.	Zanzibar	*P. ctenipes* Sladen	,, ,,
Pteraster obesus H. L. Clark	Japan, Gulf of Aden (J.M.)	*P. obesus myonotus* F.	,, ,,
	500–1000 metres. 273–546 fathoms.		
Nymphaster mœbii (Studer)	Eastern Archipelago (all areas, see p. 374)	*N. euryplax* F.	Eastern Archipelago.
Odinia austini K.	Gulf of Manaar	*O. clarki* K.	Maldives.
	1000–2000 metres. 546–1094 fathoms.		
Mediaster ornatus F.	Hawaii, Eastern Archipelago, Arabian Sea (K.)	..	..
Zoroaster angulatus A.	Gulf of Manaar, Arabian Sea	..	..

Other localities or relatives are unknown for only two species. The remaining thirteen show that the area has close affinities with those lying to the north and east of it.

Zanzibar area :

Dredging in the deep water round Zanzibar had previously been done only by the " Valdivia ". The report on the starfish collected by this vessel has, at the time of writing, only covered the family *Porcellanasteridæ*. In it there are two records :

" *Styracaster caroli* Ludwig, 2959 metres, recorded also from the Bay of Bengal by Koehler."
" *Pectinidiscus annæ* Ludwig, 400–463 metres, related to *P. sibogæ* Döderlein from the Eastern Archipelago."

The following species were collected by " Mabahiss " :

50–500 metres. 27–273 fathoms.

Species.	Other localities.	Related species.	Localities.
Mabahissaster zengi gen. et sp. n.	..	..	..
Mediaster murrayi sp. n. . .	..	..	..
Lithosoma ochlerotatus sp. n. .	..	*L. actinometra* F. . .	Eastern Archipelago.
		L. penichra F. . .	,, ,,
		L. pentaphylla (A.) . .	Bay of Bengal.
Pectinidiscus annæ Ludwig .	..	*P. sibogæ* Döderlein .	Eastern Archipelago.
Persephonaster sewelli sp. n. .	..	*P. habrogenys* F. . .	,, ,,
		P. ædiplax F. . .	
Paragonaster stenostichus F. .	Eastern Archipelago	..	..
P. ctenipes breviradiatus subsp. n.	Maldives	*P. ctenipes* Sladen . .	Eastern Archipelago.
Nymphaster mœbii (Studer) .	Eastern Archipelago (all areas, see p. 374)	*N. euryplax* F. . .	,, ,,
Anthenoides marleyi Mortensen	Natal	*A. piercei* Perrier . .	Atlantic.
	500–1000 metres. 273–546 fathoms.		
Eugoniaster ephemeralis sp. n. .	..	*E. investigatoris* (A.) .	Bay of Bengal.
		E. döderleini (K.) . .	Arabian Sea.
Pseudarchaster mozaicus A. & W.M.	Bay of Bengal, Arabian Sea (K.), Gulf of Manaar (K.)	*P. jordani* F. . . .	Hawaii, Eastern Archipelago, Arabian Sea (K.), Gulf of Manaar (K.).
		P. diversigranulatus .	Gulf of Aden.
Brisinga trachydisca F. . .	Eastern Archipelago	*B. gunnii* A. . .	Arabian Sea.
	1000–2000 metres. 546–1092 fathoms.		
Persephonaster cingulatus F. .	Hawaii, Gulf of Aden (J.M.)	*P. roulei* K. . . .	Unknown.
Hymenaster alcocki K. . .	Bay of Bengal	..	..
Freyellaster spatulifer F. . .	Eastern Archipelago	..	..
	2000–3000 metres. 1092–1640 fathoms.		
P. gracilis (Sladen) . . .	Japan, Bay of Bengal (A.), Arabian Sea (J.M.), African coast (J.M.)	..	..

Two of the seventeen species in this list, one the type of a new genus, are not known either to occur in or to have a relative in any other area. One species has a relative in the Atlantic.

All the remaining fourteen species extend to or have relatives in other areas of the Indo-Pacific region, and as in the case of the Bay of Bengal and the Arabian Sea, the affinity with areas lying to the eastward is closer than that with areas nearer at hand.

The pronounced Indo-Pacific character of the fauna is interesting since Zanzibar lies near the boundary of the zoo-geographical region. Thus the fauna at the Cape of Good Hope is quite different, and Clark (1923, 1925, see also Mortensen, 1933) records that out of thirty-nine species of Asteroid living below the littoral zone, twenty-three are endemic, and only three are Indo-Pacific forms. The boundary lies near 20° S. for, in Clark's words: "There are then only ten species (of Echinoderm) common to the South African coast and that of the Mozambique region. On the other hand of the fifty-nine species occurring at Mozambique fifty occur at Zanzibar or further northward and five others are known from some other part of the Indo-Pacific region."

African coast:

A single station, 171, lies in an enclosed basin on the south-west slope of the Carlsberg ridge at a depth of 3872 m. The following species were taken:

Species.	Other localities.	Related species.	Localities.
Eremicaster tenebrarius F.	North Pacific, American Coast	..	..
Hyphalaster tara A. & W.M.	Bay of Bengal	..	..
H. giganteus sp. n.	..	*H. parfaiti* Perrier	Atlantic.
		H. moseri Ludwig	Eastern Archipelago.
Persephonaster gracilis (Sladen)	Eastern Archipelago, Bay of Bengal (A.), Arabian Sea (J. M.) Zanzibar (J. M.)	..	..

Gulf of Aden:

The following species were collected by "Mabahiss":

0–50 metres. 0–27 fathoms.

Astropecten polyacanthus Müller & Troschel, *Luidia avicularia* Fisher, *Stellasteropsis colubrinus* sp. n., *Narcissia mohamedi* sp. n.

50–500 metres. 27–273 fathoms.

Species.	Other localities.	Related species.	Localities.
Anthenoides cristatus (Sladen)	Eastern Archipelago	*A. sarissa* (A.)	Bay of Bengal.
Paranepanthia brachiata (K.)	Arabian Sea (J.M.) Bay of Bengal	*P. joubini* (K.)	Eastern Archipelago.
Pteraster obesus Clark	Eastern Archipelago, Maldives (J.M.)	*P. obesus myonotus* F.	,, ,,
Sclerasterias mazophorus (A.)	Bay of Bengal	*S. euplecta* (F.)	Hawaii.
		S. hypacantha (F.)	Eastern Archipelago.
		S. stenactis (H. L. Clark)	Natal.

1000–2000 metres. 546-1093 fathoms.

Species.	Other localities.	Related species.	Localities.
Persephonaster cingulatus (F.) .	Hawaii, Zanzibar (J.M.)	*P. roulei* (K.) . .	Unknown.
Pectinaster agassizii (Ludwig)	Gulf of Panama	*P. mimicus* (Sladen) .	Eastern Archipelago.
Pseudarchaster diversigranulatus, sp. n.	Arabian Sea	*P. mozaicus* A. & W.M. .	Bay of Bengal, Arabian Sea (K.), Gulf of Manaar (K.), Zanzibar (J.M.).
Pectinaster agassizii granuliferus subsp. n.	..	*P. agassizii* (Ludwig) .	Gulf of Panama.
Benthopecten heteracanthus sp. n.	..	*B. violaceus* (A.) . .	Arabian Sea.
Nymphaster mœbii (Studer) .	Eastern Archipelago (all areas, see p. 374)	*N. euryplax* F. . .	Eastern Archipelago.
Cnemidaster squameus (A.) .	Arabian Sea	*C. wyvilli* F. . . .	,, ,,
Brisinga gunnii (A.) . .	,, ,,	*B. trachydisca* F. . .	,, ,,

Eight of the twelve species in this list are known from, or have close relatives in, the Eastern Archipelago. Of the remainder one is known from Hawaii and another from the Pacific coast of America. The fauna also shows affinities with those of most of the neighbouring areas.

It is thus evident that the north-western region of the Indian Ocean is a part of a vast zoo-geographical area that extends far to the eastwards in tropical and sub-tropical waters; but a study of the various areas into which I have subdivided this region indicates that the fauna of some of these areas has a closer affinity with that of the Eastern Archipelago than with that of the others; but until all the species have been examined by one person this suggestion cannot be confirmed.

REFERENCES

Alcock, A. 1893. Natural History Notes from H.M. Indian Marine Survey Steamer "Investigator", Commander C. F. Oldham, R.N., commanding. Ser. 2, no. 7. An Account of the Collection of Deep-sea Asteroidea. Ann. Mag. Nat. Hist. ser. 6, XI, pp. 73-121, pls. iv–vi.

—— 1893*a*. *Ibid.* Ser. 2, no. 9. An Account of the Collections made during the Season of 1892-93. J. Asiat. Soc. Beng. LXII, pt. 2, no. 4, pp. 171–173.

—— 1894. Illustrations of the Zoology of the Royal Indian Marine Surveying Steamer "Investigator". Echinoderma, pt. 1, pls. i-iii. Calcutta.

—— 1895. *Ibid.*, pt. 2, pls. iv and v.

—— and Wood-Mason, J. 1891. Natural History Notes from H.M. Indian Marine Survey Steamer "Investigator", Commander R. F. Hoskyns, R.N., commanding. Ser. 2, no. 1. On the Results of Deep-Sea Dredging during the Season 1890–91. Ann. Mag. Nat. Hist. ser. 6, VIII, pp. 427–440.

Bedford, F. P. 1900. On Echinoderms from Malacca and Singapore. Proc. Zool. Soc. Lond. pp. 287–299, pl. xxiv.

Bell, F. J. 1909. Report on the Echinoderma (other than Holothurians) Collected by Mr. J. Stanley Gardiner in the Western Parts of the Indian Ocean. Trans. Linn. Soc. Lond. Zool. ser. 2, XIII, pp. 17–22, pl. iii.

Benham, W. B. 1909. Scientific Results of the New Zealand Government Trawling Expedition, 1907. Rec. Canterbury (N.Z.) Mus. pp. 295–305.

Brown, R. N. R. 1910. Echinoidea and Asteroidea from the Mergui Archipelago and Moskos Islands, Lower Burmah. Proc. Roy. Phys. Soc. Edinb. XVIII, pp. 21–35.

Chun, C. 1900. Aus den Tiefen des Weltmeeres. Jena. Asteroidea, pp. 489–495, 9 figs.

Clark, H. L. 1908. Some Japanese and East Indian Echinoderms. Bull. Mus. Comp. Zool. Harv. LI, no. 11, pp. 279–311.

—— 1913. Echinoderms from Lower California, with Descriptions of New Species. Scientific Results of the Expedition to the Gulf of California in Charge of C. H. Townsend by the U.S. Fish. S.S. "Albatross" in 1911, Commander C. H. Burrage, U.S.N., commanding. Bull. Amer. Mus. Nat. Hist. XXXII, art. 8, pp. 185–236.

—— 1916. Report on the Sea-Lilies, Starfishes, Brittle-Stars and Sea-Urchins obtained by the F.I.S. "Endeavour" on the Coasts of Queensland, New South Wales, Tasmania, Victoria, South Australia and Western Australia, pp. 123, 4 pls. Sydney.

—— 1920. Report on the Scientific Results of the Expedition to the Eastern Tropical Pacific, 32. Asteroidea. Mem. Mus. Comp. Zool. Harv. XXXIX, no. 3, pp. 74–113, pls. i–vi.

—— 1923. The Echinoderm Fauna of South Africa. Ann. S. Afr. Mus. XIII, 1913–1923, pp. 221–435, pls. viii–xxiii.

—— 1923*a*. Echinoderms from Lower California: Supplementary Report. Bull. Amer. Mus. Nat. Hist. XLVIII, pp. 147–163.

—— 1925. Echinoderms from the South African Fisheries and Marine Biological Survey. Rept. no. 4, 1923–1925, pp. 34, 7 pls.

Döderlein, L. 1888. Echinodermen von Ceylon. Bericht über die von den Herren D^res. Sarasin gesammelten Asteroidea, Ophiuroidea und Echinoidea. Zool. Jahrb. (syst.) III, pp. 821–846.

—— 1896. Bericht über die von R. Semon bei Amboina und Thursday Island gesammelten Ophiuroidea und Asteroidea. Zool. Forsch. in Australien und dem Malayischen Archipel, V, pp. 301–326, pls. xviii–xxii.

—— 1916. Über die Gattung Oreaster und Verwandte. Zool. Jahrb. (syst.) XL, pp. 409–440, text-fig. 18.

—— 1917. Die Asteriden der Siboga Expedition. Uitkomsten op Zool. Bot. Ocean. en Geol. Gebied verzameld in Nederlandsch Oost-India 1899-1900 aan boord H.M. "Siboga" onder Commando van Luitenant ter zee 1^e kl. G. F. Tydeman. Leiden. I. Monog. 46*a*. Die Gattung Astropecten und ihre Stammgeschichte, pp. 1–191, 17 pls.

—— 1920. *Ibid.* II. Monog. 46*b*. Die Gattung Luidia und ihre Stammgeschichte, pp. 194–293, 3 pls.

—— 1921. *Ibid.* I. Monog. 46[1]. Porcellanasteridæ, Astropectinidæ, Benthopectinidæ, pp. 1–47, 13 pls.

—— 1924. *Ibid.* II. Monog. 46[2]. Pentagonasteridæ, pp. 48–69, pls. xiv–xix.

—— 1935. *Ibid.* III. Monog. 46[3]. Oreasteridæ, pp. 1–294, 20 pls.

Dollfus, R. Ph. 1936. *Stellasteropsis fouadi* n. gen., n. sp. Stelléride commun dans le Golfe de Suez. Bull. Soc. zool. Fr. LXI, no. 3, pp. 151–158, figs. 1–3.

Farquhar, H. 1897. A Contribution to the History of New Zealand Echinoderms. J. Linn. Soc. Zool. XXVI, pp. 186–198, pls. xiii and xiv.

Farran, G. P. 1913. Deep-water Asteroidea, Ophiuroidea and Echinoidea of the West Coast of Ireland. Sci. Invest. Fish. Br. Ire. 1912, no. 6, pp. 1–28, pls. i and ii.

Fisher, W. K. 1905. New Starfishes from Deep Water off California and Alaska. Bull. Bur. Fish. 1904, XXIV, pp. 291–320.

—— 1906. The Starfishes of the Hawaiian Islands. U.S. Fish. Comm. Bull. 1903, pt. 3, pp. 987–1130, pls. i–xlix.

—— 1908. Some Necessary Changes in the Generic Names of Starfishes. Zool. Anz. XXXIII, pp. 356–359.

—— 1910. New Starfishes from the North Pacific. I. Phanerozonia. II. Spinulosa. Zool. Anz. XXXV, no. 18; I, pp. 545–553; II, pp. 569–574.

—— 1911. Asteroidea of the North Pacific and Adjacent Waters; Pt. 1, Phanerozonia and Spinulosa. U.S. Nat. Mus. Bull. LXXVI, pp. vi, 419, 122 pls.

—— 1911*a*. New Genera of Starfishes from the Philippine Islands. Scientific Results of the Philippine Cruise of the Fisheries Steamer "Albatross", 1907-1910, no. 10. Proc. U.S. Nat. Mus. XL, pp. 415–427.

—— 1913. Four New Genera and Fifty-eight New Species of Starfishes from the Philippine Islands, Celebes and Moluccas. Proc. U.S. Nat. Mus. XLIII, pp. 599–648.

—— 1913*a*. New Starfishes from the Philippine Islands, Celebes and Moluccas. Proc. U.S. Nat. Mus. XLVI, pp. 201–224.

Fisher, W. K. 1916. New East Indian Starfishes. Proc. Biol. Soc. Wash. XXIX, pp. 27–36.
—— 1917. New Genera and Species of Brisingidæ. Ann. Mag. Nat. Hist. ser. 8, XX, pp. 418–431.
—— 1918. Notes on Asteroidea : II. Ann. Mag. Nat. Hist. ser. 9, II, pp. 103–111, pl. xiii.
—— 1919. The Starfishes of the Philippine Seas and Adjacent Waters. Bull. U.S. Nat. Mus. 100, 3.
—— 1928. Asteroidea of the North Pacific and Adjacent Waters : Pt. 2. Forcipulata. Bull. U.S. Nat. Mus. LXXVI, pp. xi, 547, 156 pls.
Goto, S. 1914. A Descriptive Monograph of Japanese Asteroidea. I. Archasteridæ, Benthopectinidæ, Porcellanasteridæ, Astropectinidæ, Luidiidæ, Pentagonasteridæ, Oreasteridæ, Gymnasteriidæ, Asterinidæ. J. Coll. Sci. Tokyo, XXIX, art. 1, pp. 808, 19 pls.
Gray, J. E. 1840. A Synopsis of the Genera and Species of the Class *Hypostoma* (*Asterias*, Linnæus). Ann. Mag. Nat. Hist. VI, pp. 175-184 and 275–290.
—— 1847. Descriptions of some New Genera and Species of Asteriadæ. Ann. Mag. Nat. Hist. XX, pp. 193–204.
—— 1866. Synopsis of the Species of Starfish in the British Museum, pp. 18, 16 pls.
Grieg, J. A. 1932. Echinodermata. Report of the Scientific Results of the Michael Sars North Atlantic Expedition. Bergen. III, pt. 2, pp. 1–47, 5 pls.
Koehler, R. 1895. Catalogue raisonné des Échinodermes recueillis par M. Korotnev aux îles de la Sonde. Mém. Soc. zool. Fr. VIII, pp. 374–423.
—— 1907. Astéries, Ophiures et Echinides recueillis dans les mers australes par la " Scotia " (1902-1904). Zool. Anz. XXXII, pp. 140–147.
—— 1909. Echinoderma of the Indian Museum. Asteroidea. Astéries recueillies par " l'Investigator " dans l'Océan Indien. I. Les Astéries de Mer profonde, pp. 143, 13 pls.
—— 1909*a*. Échinodermes provenant des Campagnes du Yacht " Princesse Alice ". Resultats des campagnes scientifiques accompliés sur son Yacht par Albert 1er, Prince Souverain de Monaco. XXXIV. Asteroidea, pp. 5–136, pls. i–xxiii.
—— 1910. Echinoderma of the Indian Museum. Asteroidea. Astéries du Musée de Calcutta. II. Les Astéries littorales, pp. 191, 20 pls.
Lamarck, J. B. de. 1816. Histoire naturelle des animaux sans vertèbres. Astéries, II, pp. 547–568.
Lieberkind, I. 1932. Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer " Valdivia ", 1898–1899, XXI, hft. 2. Asteridæ der Deutschen Tiefsee Expedition. I. Porcellanasteridæ, pp. 272–299, 14 figs., pls. xi–xvii.
—— 1935. The Danish Ingolff-Expedition, IV, pt. 10. Asteroidea, pt. 1, Porcellanasteridæ, pp. 37, 5 pls.
Livingstone, A. A. 1932. Scientific Reports of the Great Barrier Reef Expedition. Asteroidea, IV, no. 8, pp. 241–265, 2 figs. 12 pls.
—— 1934. Two New Asteroids from Australia. Rec. Aust. Mus. XIX, pp. 177–180, pl. xviii.
Loriol, P. de. 1885. Catalogue raisonné des Échinodermes recueillis par M. V. de Robillard à l'île de Maurice. II. Stellérides. Mém. Soc. Phys. Genève, XXIX, no. 4, pp. 1–84, pls. vii–xxii.
—— 1893. Échinodermes de la Baie d'Amboine. Rev. suisse Zool. I, pp. 359-426, 3 pls.
Ludwig, H. 1899. Echinodermen des Sansibargebietes. Wissenschaftliche Ergebnisse der Reisen in Madagaskar und Ostafrika in den Jahren 1889–95, von A. Voeltzkow. Abh. Senckenb. naturf. Gesell. XXI, hft. 4, pp. 537–563.
—— 1905. Reports of an Exploration off the West Coasts of Mexico, Central and South America, and off the Galapagos Islands, in Charge of Alexander Agassiz, by the U.S. Fish. Commission Steamer " Albatross " during 1891, Lieut.-Commander Z. L. Tanner, U.S.N., commanding. 35 : Reports of the Scientific Results of the Expedition to the Tropical Pacific in Charge of Alexander Agassiz on the U.S. Fish. Commission Steamer " Albatross " from August, 1899, to March, 1900, Commander Jefferson F. Moser, U.S.N., commanding. Asteroidea. Mem. Mus. Comp. Zool. Harv. XXXII, pp. 292, 35 pls., 1 chart.
—— 1907. Diagnosen neuer Tiefsee Seesterne aus der Familie der Porcellanasteriden. Zool. Anz. XXXI, no. 9, pp. 312–319.
—— 1910. Notomyota, eine neue Ordnung der Seesterne. Sitz Ber. preuss. Akad. Wiss. XXXIII, pp. 435–466.
Lütken, C. 1871. Forsatte Kritiske og beskrivende Bidrag til Kundskab om Sostjerner. Vidensk. Med. naturh. Foren. Kjøb. pp. 227–304, pl. i.
Martens, E. von. 1865. Über ostasiatische Echinodermen. Arch. Naturgesch. Jahrg. 31, I, pp. 345–360.
Möbius, K. 1859. Neue Seesterne des Hamburger und Kieler Museums, pp. 1–14, 4 pls.

Mortensen, Th. 1925. On Some Echinoderms from South Africa. Ann. Mag. Nat. Hist. ser. 9, XVI, pp. 146–154, 5 figs., pl. viii.

—— 1933. Papers from Dr. Th. Mortensen's Pacific Expedition, 1914–1916. 46 : Echinoderms of South Africa. Vidensk. Med. naturh. Foren. Kjøb. XCIII, pp. 215–400, 91 figs., pls. viii–xix.

—— 1934. Echinoderms of Hong Kong. Hong Kong Nat. Suppl. III, pp. 3–14, pls. i–viii.

Müller, J., and Troschel, F. 1842. System der Asteriden. Asteriæ, pp. 9–79, 12 pls.

Perrier, E. 1869. Recherches sur les pédicellaires des Astéries et des Oursins. Asteroidea, pp. 5–110, pls. i and ii.

—— 1875. Révision des Stellérides du Muséum. Arch. Zool. exp. gén. V, pp. 1–104 and 209–304.

—— 1878. Études sur Repartion Geographique des Astéries. Nouv. Arch. Mus. Hist. nat. Paris, ser. 2, I, pp. 1–108.

—— 1881. Description sommaire des éspèces nouvelles d'Astéries. Bull. Mus. Comp. Zool. Harv. IX, no. 1, pp. 1–31.

—— 1884. Mémoire sur les Étoiles de Mer recueillis dans la Mer des Antilles et le Golfe de Mexique durant les Expéditions de Dragages faites sous la direction de M. Alexandre Agassiz. Nouv. Arch. Mus. Hist. nat. Paris, ser. 2, VI, pp. 127–276, pls. i–ix.

—— 1885. Première note préliminaire sur les Échinodermes recueillis durant les campagnes de dragages sous-marins du " Travailleur " et du " Talisman ". Ann. Sci. nat. Zool. ser. 6, XIX, pp. 1–72.

—— 1894. Expéditions scientifiques du " Travailleur " et " Talisman " pendant les années 1880, 1881, 1882, 1883. Échinodermes (Asteroidea), pp. 431, 36 pls.

—— 1897. Contribution à l'étude des Stellérides de l'Atlantique nord. Résultats des Campagnes scientifiques du Prince de Monaco, XI, pp. 58, 4 pls.

Retzius, A. J. 1805. Dissertatio sistens species cognitas Asteriarum.

Simpson, J. J., and Brown, R. N. R. 1910. Asteroidea of Portuguese East Africa collected by Jas. J. Simpson. Proc. Roy. Phys. Soc. Edinb. XVIII, pp. 45–60.

Sladen, W. P. 1889. Report on the Asteroidea collected by H.M.S. " Challenger " during the years 1873–1876. " Challenger " Reports, Zoology, XXX, pp. 893, 117 pls., 1 chart.

Sluiter, C. P. 1895. Die Asteriden des Museums zu Amsterdam. Bijd. tot. Dierk. Koninkl. Zool. Genoot. " Natura Artis Magister ". Amsterdam, XVII, pp. 51–74.

Studer, T. 1884. Verzeichniss der während der Reise S.M.S. " Gazelle " um die Erde 1874–1876 gesammelten Asteriden und Euryaliden. Abh. preuss. Akad. Wiss. pp. 1–64, pls. i–v.

Verrill, A. G. 1899. Revision of Certain Genera and Species of Starfish with Descriptions of New Forms. Trans. Conn. Acad. Arts Sci. X, pp. 145–234, 8 pls.

—— 1915. Report on the Starfishes of the West Indies, Florida, Brazil, etc. Iowa City Univ. Bull. VII (I), pp. 232, 29 pls.

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DESCRIPTION OF PLATE I.

FIG. 1.—*Dipsacaster farquharsoni*. Actinal surface. × ¾.
FIG. 2.—*Narcissia mohamedi*. Actinal surface. × ¾.
FIG. 3.—*Hyphalaster giganteus*. Actinal surface. × ¾.
FIG. 4.—*Dipsacaster farquharsoni*. Abactinal surface. × ¾.
FIG. 5.—*Persephonaster sewelli*. Actinal surface. × ¾.
FIG. 6.—*Persephonaster sewelli*. Abactinal surface. × ¾.
FIG. 7.—*Hyphalaster giganteus*. Abactinal surface. × ¾.
FIG. 8.—*Nardoa faouzii*. Abactinal surface. × 1.
FIG. 9.—*Nardoa faouzii*. Actinal surface. × ¾.
FIG. 10.—*Narcissia mohamedi*. Abactinal surface. × 1.

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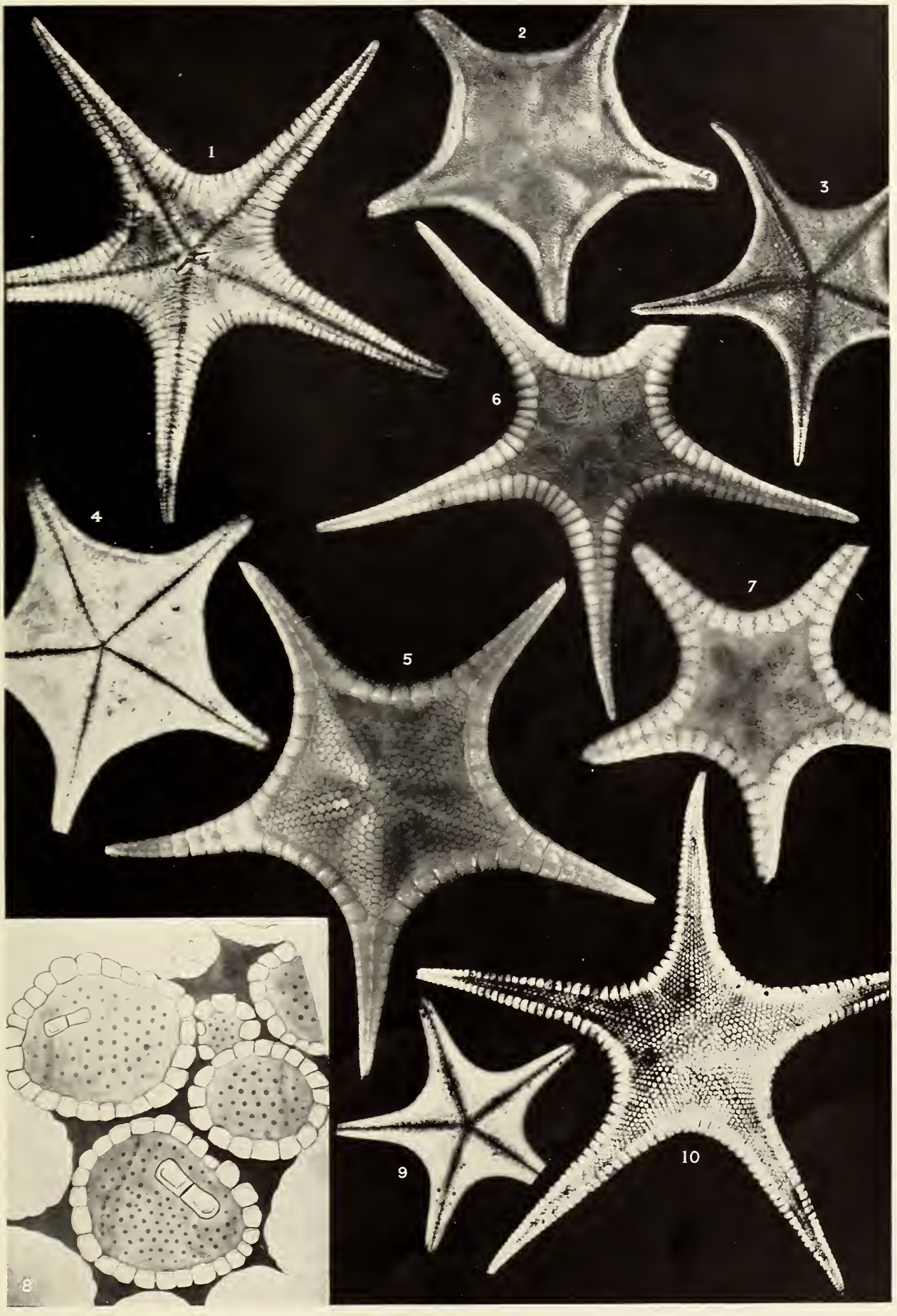
DESCRIPTION OF PLATE II.

FIG. 1.—*Pseudarchaster mozaicus.* St. 122. Actinal surface. × ⅔.
FIG. 2.—*Eugoniaster ephemeralis.* Abactinal surface. × ⅔.
FIG. 3.—*Astroceramus cadessus.* Actinal surface. × ⅔.
FIG. 4.—*Eugoniaster ephemeralis.* Actinal surface. × ⅔.
FIG. 5.—*Astroceramus cadessus.* Abactinal surface. × 1.
FIG. 6.—*Paragonaster ctenipes breviradiata.* Abactinal surface. × 1.
FIG. 7.—*Lithosoma ochlerotatus.* Abactinal surface. × 1.
FIG. 8.—*Eugoniaster ephemeralis.* Radial abactinal plates. × 40.
FIG. 9.—*Lithosoma ochlerotatus.* Actinal surface. × ¾.
FIG. 10.—*Pseudarchaster mozaicus.* St. 122. Abactinal surface. × ⅔.



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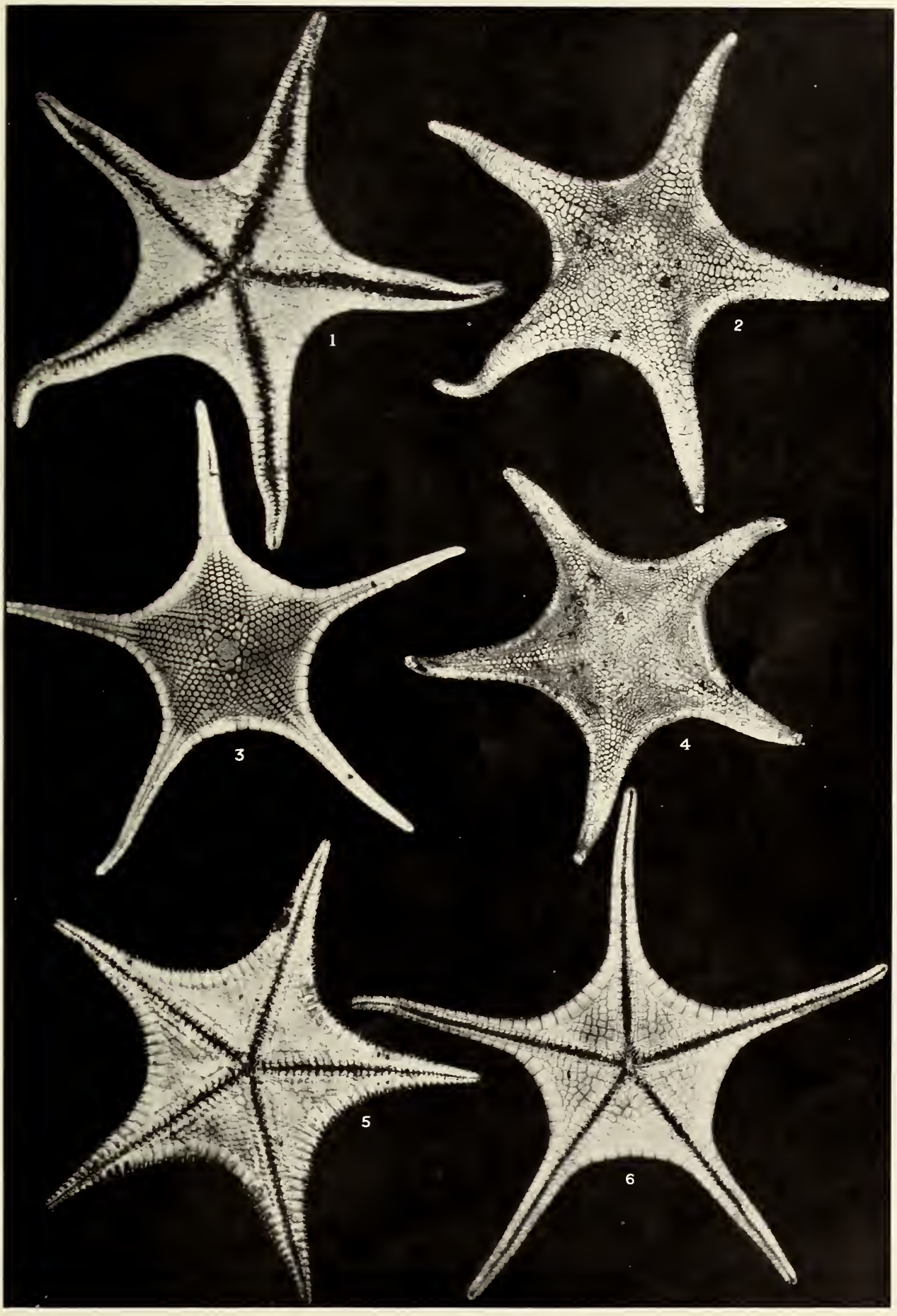
DESCRIPTION OF PLATE III.

FIG. 1.—*Mediaster murrayi*. St. 107. Actinal surface. × 1.
FIG. 2.—*Mediaster murrayi*. St. 109. Abactinal surface showing fusion of plates along ray. × 1.
FIG. 3.—*Rosaster cassidatus*. Abactinal surface. × 1.
FIG. 4.—*Mediaster murrayi*. Abactinal surface of normal specimen. × 1.
FIG. 5.—*Anthenoides cristatus*. St. 194. Actinal surface. × 1.
FIG. 6.—*Rosaster cassidatus*. Actinal surface. × 1.



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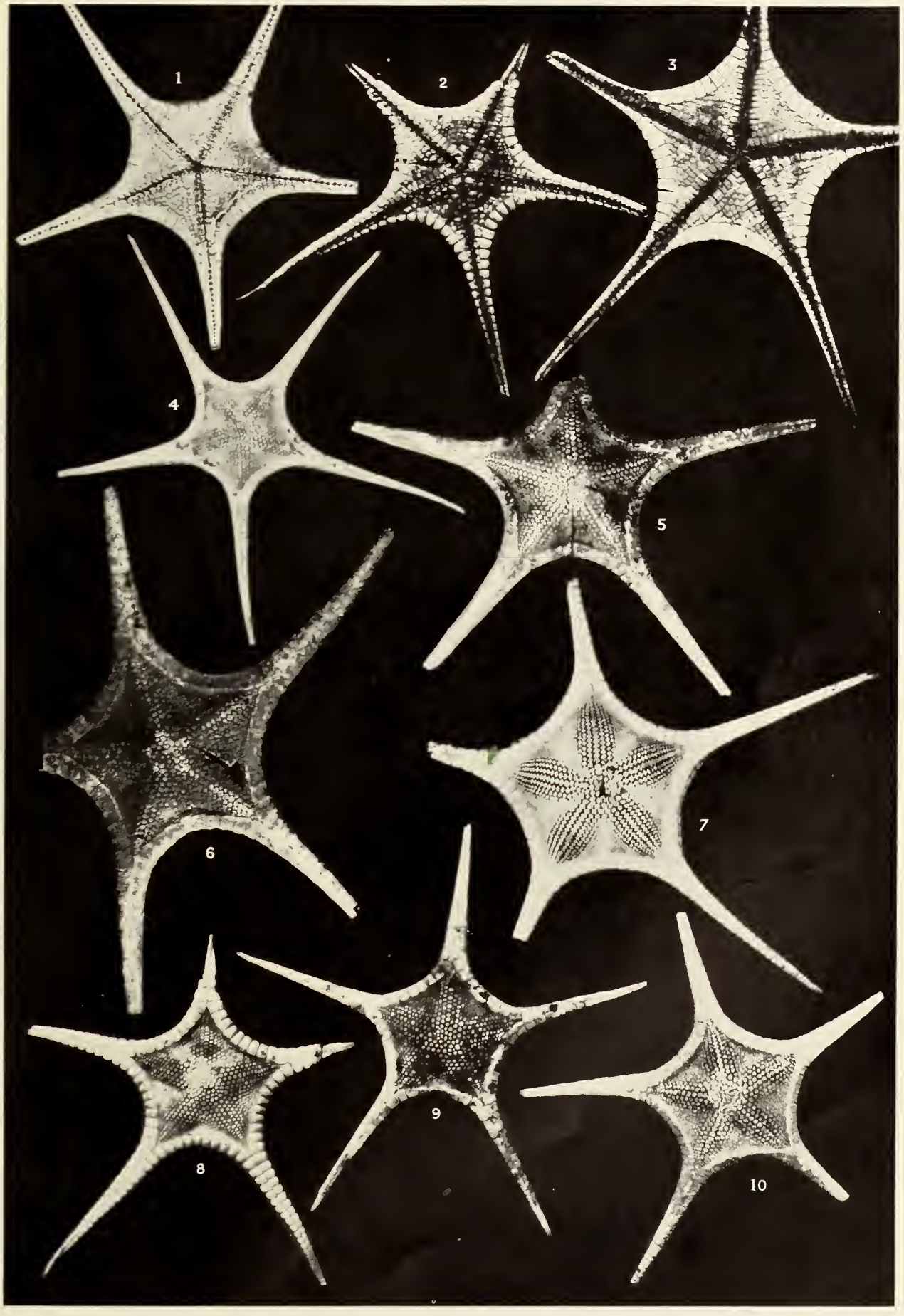
DESCRIPTION OF PLATE IV.

Nymphaster mœbii. All figures × $\frac{5}{8}$.

Fig. 1.—No. 98, 11. St. 122 (Zanzibar). Actinal surface.
Fig. 2.—No. 100*f*. St. 184 (Gulf of Aden). Actinal surface.
Fig. 3.—No. 96. St. 145 (Maldives). Actinal surface.
Fig. 4.—No. 17*c*. St. 105 (Zanzibar). Abactinal surface.
Fig. 5.—No. 98, 14. St. 122 (Zanzibar). Abactinal surface.
Fig. 6.—No. 98, 16. St. 122 (Zanzibar). Abactinal surface.
Fig. 7.—No. 96. St. 145 (Maldives). Abactinal surface.
Fig. 8.—No. 100*f*. St. 184 (Gulf of Aden). Abactinal surface.
Fig. 9.—No. 112*c*. St. 115 (Zanzibar). Abactinal surface.
Fig. 10.—No. 98, 11. St. 122 (Zanzibar). Abactinal surface.



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DESCRIPTION OF PLATE V.

FIG. 1.—*Anthenoides cristatus.* Abactinal surface. × 1.
FIG. 2.—*Stellasteropsis colubrinus.* St. 53. Actinal surface. × 1.
FIG. 3.—*Monachaster umbonatus.* Actinal surface. × 1.
FIG. 4.—*Stellasteropsis tuberculiferus.* Actinal surface. × 1.
FIG. 5.—*Stellasteropsis colubrinus.* Abactinal surface. × 1.
FIG. 6.—*Monachaster umbonatus.* Abactinal surface. × 1.
FIG. 7.—*Stellasteropsis tuberculiferus.* Abactinal surface. × 1.

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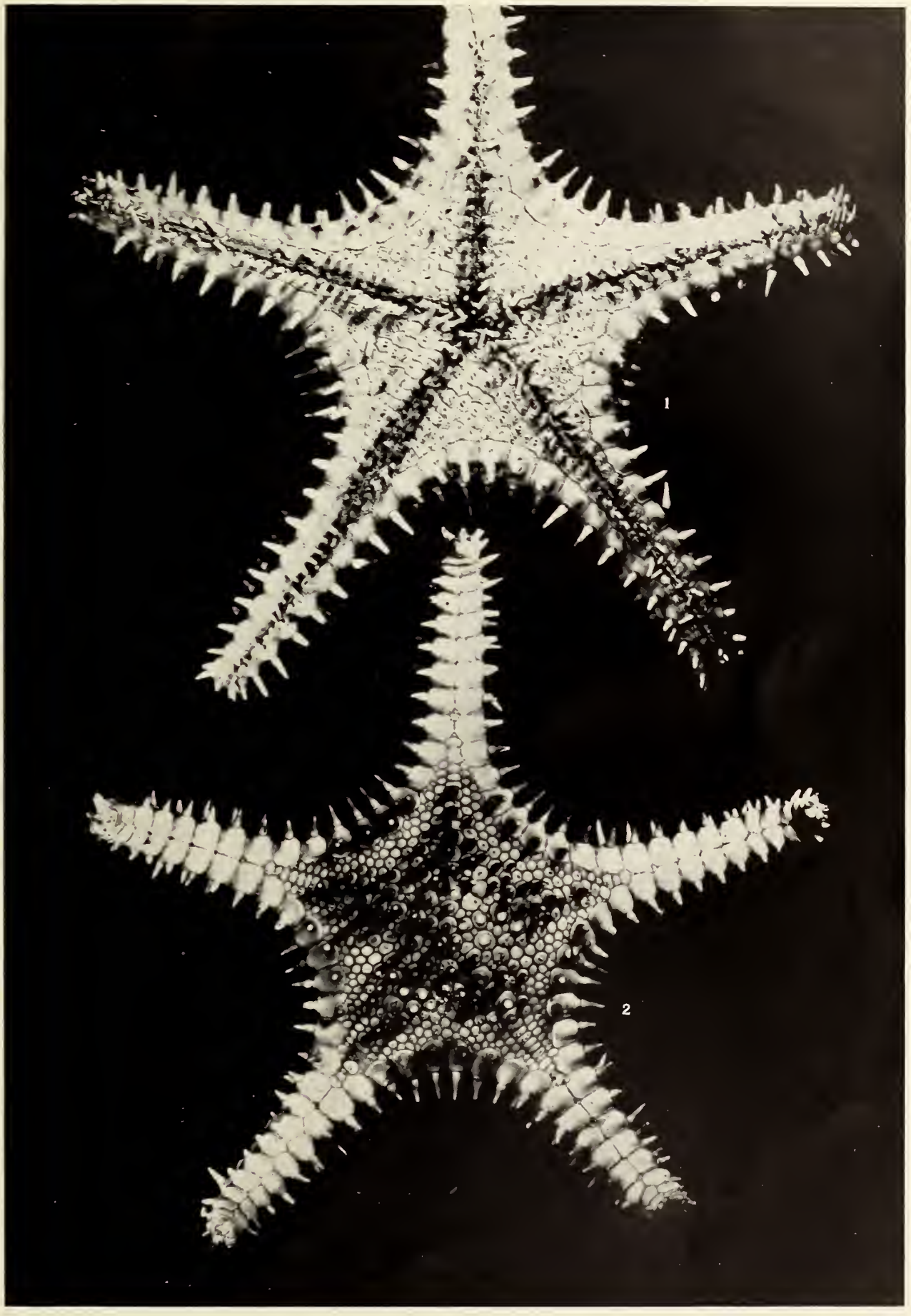
DESCRIPTION OF PLATE VI.

Mabahissaster zengi. × 1.

Fig. 1.—Actinal surface.
Fig. 2.—Abactinal surface.



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